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Broadcasting in Great Britain.

THE Postmaster-General has, it is announced, decided temporarily to suspend the issue of licences for the reception of wireless telegraphy and telephony, except to those engaged upon experimental work. In an official statement sent out by the Post Office in relation to the broadcasting situation, it is explained that the Postmaster-General has been prompted to adopt the course he has taken in connexion with the issue of licences for reception purposes owing to the fact that there has been a divergence of views concerning the details with regard to the constitution of the company which it is proposed to form for the purpose of providing the broadcasting services. Not only have the proposed articles of association of the proposed broadcasting company proved unacceptable, as a whole, to the Postmaster-General and his advisers, but also, it would appear, that differences on essential points have also been manifest between the members of the committee dealing with the Postmaster-General in this matter. Considerable progress has, it is stated, now been made towards the solution of the differences between the members of the committee in question, and, at a conference held at the Post Office on September 12, an agreement was reached as to the conditions under which the Postmaster-General will issue the necessary licences for the erection of the broadcasting stations; it therefore now only remains for the Post Office officials and the committee representing the proposed company to settle certain details.

In the official statement in question it is announced that the Postmaster-General and the committee both desire it to be known that membership of the proposed broadcasting company will not, of itself, entitle a member to use the patents of other members in the manufacture of receiving apparatus. The manner in which the broadcasting situation is being handled by the Post Office has, in some quarters, caused considerable disquietude; the policy which is being pursued by the Postmaster-General, whereby an attempt is to be made to control the broadcasting situation by and through the means of the proposed articles of association of the company which it is proposed to license to provide the broadcasting services, certainly seems to be one of doubtful wisdom. As the provisions to be included in the proposed articles of association at the instance or with the approval of the Postmaster-General have not yet been made public, it would be premature further to discuss the matter at the moment.

A point of considerable importance, which requires

early attention, is the attitude the Post Office is taking in connexion with the issue of licences for experimental work. In the official statement, to which reference has already been made, it is indicated that the Postmaster-General intends in future to issue licences for experimental stations alone to those who can satisfy him that they have a sufficient knowledge of the subject to enable them to make a proper use of such licences. It is surmised in some quarters that this departmental rule has been framed with the view of restricting the grant of licences for experimental work alone to trained scientific workers. In the interests of the progress of science it is essential that the terms and conditions under which it is possible to obtain a licence for experimental work shall not be made so exacting and stringent as to exclude the amateur from the field of wireless research.

The requirements in relation to the issue of licences for experimental stations are definitely laid down in clause 2 of the Wireless Telegraphy Act, 1904 (4 Ed. 7, c. 24), wherein it is provided that "where the applicant for a licence proves to the satisfaction of the Postmaster-General that the sole object of obtaining the licence is to enable him to conduct experiments in wireless telegraphy, a licence for that purpose shall be granted, subject to such special terms, conditions and restrictions as the Postmaster-General may think proper, but shall not be subject to any rent or royalty." The language used in this clause is sufficiently clear to show that it cannot have been the intention of the legislature in any way to penalise the amateur experimentalist in connexion with the procuring of a licence for experimental work. In the matter of the grant of such licences the amateur experimentalist and the trained scientific worker have an equal claim upon the Postmaster-General, provided that they can prove to his satisfaction that the station which they desire to equip is an experimental one, in contradistinction to one fitted up for commercial work. The amateur should receive the fullest encouragement and consideration from the Post Office. Mischief will alone result should the steps which the Postmaster-General and his advisers are contemplating with regard to the issue of licences for experimental work have the unfortunate effect of moving amateurs to evade the official regulations and the provisions of the Wireless Telegraphy Act, 1904.

The Problem of Solution.

THE problem of solution has engaged the attention of many men of science from the time of Newton to the present day, and it cannot be said that a complete and all-embracing theory has yet been advanced that will interpret all the observed facts. The subject lends itself admirably to those who concern themselves with pointing out weaknesses of accepted conceptions without replacing these ideas by adequate substitutes.

A contributor, writing under the pseudonym Dr. B. Lagueur, in the *Chemical Age* of September 2, very ably and wittily adopts the style of the "Compleat Angler," and produces an imaginary conversation between a "Chymist" (baptised Henry), in whose chemical philosophy there has not arisen the necessity of adopting the ionic hypothesis, and a "Friend," who, being a creation of the author and therefore fundamentally of similar persuasion, is unable to make a satisfactory case for its adoption.

Of the theories advocated it is now generally recognised that the older conception of hydrate formation is insufficient to account for the experimental results obtained. The hydrone theory of Armstrong appears to be that beloved of the "Chymist," and explains solution by assuming the existence of new molecules formed by the union of the water with the solute. It has a certain measure of experimental support, but, despite this, despite the known complexity of water, and despite the crystal work of Bragg, it embodies a number of assumptions difficult to verify, and by itself is scarcely likely to displace the more firmly established hypothesis of Arrhenius, which, though revolutionary, imperfect, and easily attacked, yet fulfils the functions of a hypothesis, and therefore serves a useful purpose.

The ionic hypothesis has explained many facts hitherto extremely puzzling; it has opened out new lines of research, and "as a working hypothesis gives qualitative and quantitative explanation of a large number of chemical phenomena which can otherwise only be accounted for in a vague and unsatisfactory way." The solvate theory—a combination of the original ionic hypothesis with the hydrate and hydrone conceptions—has been the outcome of a long series of experiments on solution by Jones and his collaborators in America. The ionic hypothesis, shorn of the frills and furbelows given to it by enthusiasts, is generally accepted with certain mental reservations as to the existence of ions, except by those who, as Jones says, "oppose it after a careful study of the facts or are unable or indisposed to adapt themselves to new ideas."

Many hypotheses are at best unstable and transient, but before any are discarded they must be killed, and the death of the theory of electrolytic dissociation is not yet, notwithstanding the thrusts given to it in the article in our contemporary.

The New Way of Thinking Physical Reality.

(1) *The Philosophy of Humanism and of other Subjects.* By Viscount Haldane. Pp. xiv + 302. (London: J. Murray, 1922.) 12*s*. net.

(2) *L'Expérience humaine et la causalité physique.* Par Prof. Léon Brunschvicg. (Bibliothèque de Philosophie Contemporaine.) Pp. xvi + 625. (Paris: Félix Alcan, 1922.) 30 frs.

(3) *La Notion d'espace.* Par Prof. D. Nys. (Fondation Universitaire de Belgique.) Pp. 446. (Bruxelles: Robert Sand; London: Oxford University Press, 1922.) 15*s*. net.

(4) *The Evolution of Knowledge.* By George Shann. Pp. vii + 100. (London: Longmans, Green and Co., 1922.) 4*s*. 6*d*. net.

THE direction which scientific research has taken in the twentieth century is imposing on philosophy a task the magnitude of which is probably not yet realised by any one. Aristotle, in his doctrine of the four causes and in his discovery of the syllogism, the logical instrument which gave that doctrine the appearance of precision, determined the type and the mode to which all succeeding scientific research right up to modern times has adhered. The essential thing in the Aristotelian doctrine is that the analysis of the physical universe proceeds in precisely the same way as the analysis of the elementary conditions which govern the production of a work of art. There is, that is to say, a matter on which an agent impresses a form in order to express an end or purpose. The modern sciences of biology and psychology had already begun to undermine this æsthetic mode of thinking reality and now the Einstein theory in mathematical physics has swept away its foundations. The result is that once more in human history physics and metaphysics are joined together. The union has been brought about by physical science itself, without any betrayal of its positive and experimental character, by fearless acceptance of the apparently paradoxical results of experiments. It is the outcome, we can now see, of a historical progress of pure science in the last three centuries, continuous in its development from Galileo to Clerk Maxwell, Mach and Einstein, which has led to a complete revolution in the way of thinking physical reality.

The philosophical current of human thought, although always a reflection of the scientific current, has not the same rhythm. It happens at times, unexpectedly and as if by a sudden explosion, that the scientific current is interrupted; some wholly unlooked-for results of experimental investigation have occurred, and the human mind has sprung at once to the general principles whence those results proceed. A new vision of truth then opens out before human consciousness involving its whole conception of the universe and mind. It was such a vision which produced the new birth of modern philosophy in the seventeenth century. To-day a new and most startling discovery, following indeed a long historical development, but a development we can appreciate only now because the discovery has given us the vantage ground from which to look back on the history, is opening to us a new vision of truth and making us rethink our whole concept of the nature of physical reality.

(1) and (2) It is this new way of thinking physical reality which, each in his own way, the authors we have grouped together are seeking to express. In the case of Lord Haldane's "Humanism" and Prof. Brunschvicg's "L'Expérience humaine" there is full consciousness of it and a direct purpose of exposition. It is noteworthy that two such books, widely different in their method and scope and yet so singularly in agreement, both in their viewpoint and aim, should appear together. Lord Haldane, who is not a mathematician, devotes himself to detailed philosophical analysis of the new mathematical concept, while Prof. Brunschvicg, a mathematician of distinction and known to us chiefly by his *editio princeps* of Pascal's works, traces with an extraordinary grasp of details the historical development of the concept of physical causality which has resulted in the generalised theory of relativity; and both interpret to us the new concept of the physical universe in practically identical terms. The humanism of the one is the human experience of the other, and Lord Haldane's "foundational nature of knowledge" is Prof. Brunschvicg's "philosophie de la pensée."

The cosmology of Einstein differs fundamentally from every previous doctrine inasmuch as it discards both the factors which in the long history of human thought have contended against one another for pre-eminence. It regards neither the definition of the concept, whence deduction is made, nor the datum of experience, on which induction is based, as fundamental. Einstein's world is a world of figures, supposing neither *a priori* concepts nor sensible images. These figures, however, are not fictions, they are not even abstractions, they correspond to coefficients which reality furnishes. Mathematics determines for us the *invariant* which passes from one system to another.

Between Newton and Einstein, Prof. Brunschvicg tells us, there is this difference that according to Newton the thing to be measured has an absolute content, inaccessible it may be directly to man, but certainly accessible to God. That is to say, the Newtonian

universe would be an object of intuition, that is, would form a picture, at least to God. According to Einstein, we cannot say, speaking absolutely, that there is any picture even for God. The picture is only known as a function of the frame. That is, the things measured are only known through the measurings, and the measurings are bound up with the things they serve to measure. The understanding of this reciprocity makes it impossible to separate and consider apart what, for the convenience of language alone, we distinguish as frame and picture. Science goes in a kind of perpetual oscillation, with an ever-narrowing adaptation, from the measured to the measuring, from the measuring to the measured. Thus, considered from the point of view of the measuring, it is impossible by any physical means whatever to reveal a uniform movement of translation in which both the observer and all that he observes participate. Considered from the point of view of the measured, the velocity of light is the only velocity which is unchanged when we pass from one system of reference to another, and in the electromagnetic universe this velocity plays the rôle which infinite velocity formerly played in the mechanistic universe. The constancy of the velocity of light implies further an irreducible plurality of physical measurements of times, because the various groups of observers cannot make clocks from which they can detach themselves and compare them as instruments with one another. They are themselves the inhabitants of a clock, prisoners in their own time-measuring instrument, bound to its state whether they suppose it at rest or moving.

To most of us, however, whether our interest in the principle of relativity is scientific or philosophical, the greatest stumbling-block is probably the hypothesis of a finite universe. This seems a contradiction in thought and at least an unnecessary appendage of the principle. Prof. Brunschvicg shows us very clearly why the equations lead necessarily to this hypothesis, for they allow us to show that without it the total reduction of inertia to reciprocal action between masses is impossible.

The metaphysics which the new physics implies means therefore a complete revolution both in philosophy and science. As metaphysics it claims neither priority over science nor independence of it, not even the independence implied by Kant in the theory that the conditions of experience are *a priori*. This is not because metaphysics has learnt to be humble or to be resigned, but because in reality there is a contradiction in the very notion that by reflecting on science we can disengage certain antecedent conditions capable of enclosing all past and future knowledge in static schemes. On the side of positive science we have come to see that by the pure experimental method we are not and cannot be brought into contact with elemental constituents of experience, whether material as Democritus conceived them, or intelligible as Plato conceived them, or sensible as Hume conceived them. The realities we are dealing with in physical science are statistical, so that all reflection on the results of experiment is, not an approach to the absolute, but a progress in the discovery of relativity. The early nineteenth-century ideal of a pure positive science perpetually progressive by means of a division of labour has given place in the twentieth century to a new and more subtle idea, the idea of a progress which is reflective.

(3) Prof. D. Nys's "La Notion d'espace" is a valuable book, but belongs to a different category from that of the two works we have mentioned. It is the fourth volume of his "Cosmologie ou Étude philosophique du monde inorganique," and is encyclopædic in its treatment of the subject. It includes in a general view of the various philosophical doctrines a very clear account of the recent theories with the criticisms upon them and is a model of careful compilation. It develops no original theory and is written from the point of view of neo-scholasticism.

(4) Mr. Shann's short treatise on "The Evolution of Knowledge" is the work of one who knows how to think out a problem for himself. It deals with a different aspect of relativity from that of the physical principle, namely, with the nature of the vital need which has produced in man and some animals the function of knowing. All those friends of Mr. Shann who have received from him from time to time his excellent privately printed pamphlets, bound in the well-known scarlet wrapper, will welcome this published work.

H. Wildon Carr.

Ceremonial Exchange.

Argonauts of the Western Pacific: An Account of Native Enterprise and Adventure in the Archipelagoes of Melanesian New Guinea. By Dr. Bronislaw Malinowski. Pp. xxxii + 527. (London: G. Routledge and Sons, Ltd., 1922.) 21s. net.

In this volume Dr. Malinowski has given the first-fruits of his extended stay in the Trobriands, a group of islands off the south-east of New Guinea. A good deal of more or less desultory information, published in Government reports and elsewhere, has indicated that these islanders differ in some respects from their neighbours; Dr. Malinowski now shows how intimately they are all associated with one another, not merely by ordinary trade, but by a hitherto unrecorded and very remarkable system of ceremonial

exchange, known as Kula, with which this book is almost solely concerned.

The exchange takes place between partners who may reside in the same island, but for the most part in different islands. The Kula articles of value are shell-necklaces of a special type and armlets made of Conus shell. The former always travel N.-E.-S.-W., *i.e.* clockwise, and the latter in the contrary direction, but other articles of value may be implicated in the transactions in a subsidiary manner. The islands mainly concerned in Kula are those between Nada and the Trobriands, the Amphletts, part of the southern d'Entrecasteaux and the Tubetube group. The real Kula necklaces and the arm-shells have various worth, and highly valued ones have individual names, and their wanderings are followed with interest. The ownership, or rather trusteeship, of each object is temporary, and ranges from a few minutes to one year or possibly two, but a man who retains an object beyond a year is regarded as a mean person. The exchange is by the natives sharply differentiated from barter, as no haggling takes place. An equivalent gift is always expected, but cannot be demanded or enforced, the only punishment for failing in this being loss of esteem. If at any time an equivalent gift cannot be bestowed, intermediate gifts will smooth the way till the real repayment takes place. Meanness is the most despised vice, and generosity the essence of goodness. *Noblesse oblige* is in reality the social norm regulating their conduct. This does not mean that people are always satisfied and that there are no squabbles nor even feuds about the transactions. It is obvious that however much a man may want to give a good equivalent for the object received, he may not be able to do so; and then, as there is always a keen competition to be the most generous giver, a man who has received less than he gave will not keep his grievance to himself but will brag about his own generosity and compare it with his partner's meanness; the other resents it, and the quarrel is ready to break out. All the preparatory activities, as well as those connected with the voyages and the ceremonies of exchange, are permeated by magic, as indeed is the whole economic life of the people.

The most important character of Kula is the mental attitude of the natives towards it. The objects of the Kula are neither used nor regarded as currency, as they are never used as a medium of exchange or as a measure of wealth; they serve merely to be owned and displayed and then exchanged. It is through being the means of arousing envy and conferring social distinction and renown that these objects attain their high value and form one of the leading interests in native life. The ceremonial attached to the act of giving and the manner of carrying and handling shows distinctly that they are not mere merchandise, but something that confers dignity on a man, that exalts him, and which he therefore treats with veneration and affection. Nothing of the same kind has been described elsewhere, but something analogous may be discovered now that attention has been directed to it. The potlatch of British Columbia, for example, is worth reconsidering in the light of this book.

Dr. Malinowski has not confined himself to a mere detailed description of Kula, but he has endeavoured, apparently with great success, to explain its psychological significance. Kula so pervades the life, thought, and emotion of the people concerned in it that it seems in some respects to fulfil functions which are characteristic of many religions, but with magic supplying the place of spiritual powers. The system might almost be termed the Kula cult, as Dr. Malinowski seems to hint; but he distinctly states that the natives worship nothing.

The inter-insular Kula requires seaworthy canoes, and Dr. Malinowski describes how these are made, and the series of magical rites which accompany every stage in their manufacture, equipment, and sailing. The smaller fishing canoes are owned by one man, but the sea-going canoe is constructed by a group of people; it is owned, used, and enjoyed communally, and this according to definite rules, all of which are described with careful detail and psychological insight. To the natives a canoe of this type is a marvellous achievement, a thing of beauty, and an object permeated by magic. "He has spun a tradition around it, he adorns it with his best carvings, he colours and decorates it. It is associated with journeys by sail, full of threatening dangers, of living hopes and desires to which he gives expression in song and story. In short, in the tradition of the natives, in their customs, in their behaviour, and in their direct statements, there can be found the deep love, the admiration, the specific attachment as to something alive and personal, so characteristic of the sailor's attitude towards his craft."

An outstanding merit of this book is that it is a well-considered study in ethnographical method; indeed the author's remarks on field-work will prove of great value for the guidance of future workers. A large number of magical formulæ and oral texts is given in the native language and in translation, which provides unusual documentary evidence of exceptional value for the elucidation of native psychology. The book is well illustrated and of reasonable cost, for which the publishers are to be thanked. Mr. Robert Mond and others, by their liberality, have enabled these investigations to be made, and they have the satisfaction of knowing that they have afforded an

opportunity for a young student to produce a work of absolutely first-class value. It is to be hoped that Dr. Malinowski will be able to publish in full the remainder of his material, which, judging from this sample, will mark a distinct progress in ethnographical research and interpretation. A. C. HADDON.

Pure and Applied Electricity.

(1) *Einführung in die Theorie der Elektrizität und des Magnetismus. Zum Gebrauch bei Vorträgen, sowie zum Selbstunterricht.* Von Prof. Dr. Max Planck. Pp. v+208. (Leipzig: S. Hirzel, 1922.) 42 marks.

(2) *Elettrotecnica elementare con numerosi problemi.* By A. Occhialini. Vol. 1: *Magnetismo—Elettrostatica — Elettrochimica — Elettrodinamica — Elettromagnetismo — Induzione elettromagnetica.* Pp. v+344. (Firenze: Felice Le Monnier, n.d.) n.p.

(3) *Installations électriques industrielles: choix du matériel.* Par R. Cabaud. Pp. 316. (Paris: J.-B. Baillière et Fils, 1922.) 10 francs.

THE first of these three books discusses the groundwork of the theory of electricity, the next discusses the experimental laws and their laboratory applications, and the third is a severely practical work for the commerical electrician. They are all introductions to the subject, but they are intended for very different classes of readers.

(1) Dr. Max Planck's work is philosophical, and presupposes a knowledge of mathematics and of the mathematical theory of electricity which is possessed by few. The foundations on which the ordinary mathematical equations rest are examined, and particular stress is laid on the units in which they are measured. The Gaussian, the electrostatic, and the electromagnetic systems of units are considered. The work will be very welcome to the pure theorist and will increase his confidence in the soundness of the physical basis of the mathematical theory. The clear distinction made between magnetic force and magnetic induction is very convincing. The experimenter will find little that is directly helpful to him in this book, but he will appreciate, however, the author's method of getting the capacity of an ellipsoid and the deductions that can be made from it.

(2) The second work under notice is very similar to the standard English books on experimental electricity and magnetism. The author's descriptions of the main phenomena are very clear, and the numerous examples given are instructive. A very full discussion is given of the problem of a number of batteries of different electromotive forces and resistances in parallel with one another. A thorough knowledge of this problem is a great help to students when they come to the corresponding problems of dynamos or alternators running in parallel with one another. The definition given of the temperature coefficient of metals, however, is not sufficiently accurate for modern requirements. The rating of a dynamo depends on its temperature after a run at full load, and the temperature of the coils is computed from their measured resistance and a knowledge of the temperature coefficient of copper. As the problem is one of great commercial importance it is necessary to distinguish between the temperature coefficeint of the volume resistivity, the mass resistivity, and the constant mass resistance. These are all different and vary with the lower of the two temperatures considered. The approximate formulæ for the self-induction of a coil are given, but we think that their limitations should have been stated.

(3) M. Cabaud's book is very general and can be appreciated only by a technical expert. It presupposes a thorough knowledge of practical electrical engineering. In the first section of the book a general discussion is given of the kind of electric machine required to do special work; for example, whether a direct-current or an alternating-current machine will be the more useful. In the latter case also the question of whether it is to be single phase or polyphase is considered. The efficiency of the machine, its heating under load, the electric strength of the insulating wrappings, etc., have all to be considered. In the second section the characteristics of the machines, whether rotating or stationary, are described. In the last section the usefulness of the various characteristics are discussed, and the important question of the best guarantees that should be demanded from the manufacturers is considered.

The Petroleum Industry.

(1) *Encyclopédie Scientifique: Bibliothèque de géologie et de minéralogie appliquées: Les Gisements de pétrole.* Par Jean Chautard. Pp. viii+viii+330. (Paris: Gaston Doin, 1922.) 14 fr.

(2) *The Oil Encyclopedia.* By Marcel Mitzakis. Pp. xvi+551. (London: Chapman and Hall, Ltd., 1922.) 21s. net.

(3) *The Economics of Petroleum.* By Joseph E. Pogue. Pp. ix+375. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1921.) 33s. net.

THE "Encyclopédie Scientifique" constitutes a comparatively new departure in French technical literature, and has for its scope the ultimate publication of some thousand volumes dealing with the various phases of pure and applied science. M. Jean Chautard's

little book (1) is apparently one of the earliest of the series, and if it indeed sets the standard of future productions, this encyclopedia will undoubtedly prove of very great value. Well written, profusely illustrated with photographs, maps, plans, diagrams and sections, this particular volume covers a wide subject in a minimum of space. The major part is concerned with the geology of petroleum and a consideration of the petroliferous regions of the world. Other chapters deal with the nature of petroleum, natural gas and solid hydrocarbons, their origin, mode of occurrence, surface manifestations, exploration, and economic development.

The author has drawn on most of the more recent literature for his descriptions of the oil occurrences throughout the world, and in consequence the information given is most up-to-date; several minor errors occur in the spelling of place-names, but these will doubtless be corrected in a future edition. Not the least valuable of the contents of the book are the bibliography, and a noteworthy preface by M. Louis Mrazec, whose structural theories, incidentally, receive careful treatment in the text. At the present time, when scientific books are usually published at prohibitive prices, it is gratifying to be able to recommend a volume which is both an inexpensive and necessary addition to the library of petroleum technology.

(2) In the "Oil Encyclopedia," by Mr. Marcel Mitzakis, we meet with a very different type of book, one which will doubtless make its appeal more to the commercial than to the scientific community. To the many people whose province it is to control the destinies of oil-land development and economics—the administrative as distinct from the technical branch of the industry—this volume will prove of value, presenting as it does the many and varied phases of oil-mining in the form of an elaborate and explanatory index. The volume includes information of a biographical, geological, geographical, and chemical nature, apart from its treatment of the multitudinous technical factors pertaining to the oil industry, and as a source of broad reference to such matters, has much to commend it. It lacks in many cases, however, that atmosphere of authority and degree of accuracy which are to be expected in a work purporting to be for widespread use, and judged from the scientific point of view, leaves much to be desired. In several cases the definitions, especially of geological terms, are decidedly loose, if not actually erroneous, while some of the facts given are by no means correct, nor are they always up-to-date. As examples we may quote the definition of "æolian" given as "a special kind of sand found in oil-bearing strata," and the paragraph devoted to the explanation of the word "Cambrian" since "so many oil strata occur disseminated among Cambrian deposits." Further, the oil potentialities and realities of Great Britain are allotted space out of all proportion to their importance, while the remarks on the natural gas resources of Heathfield, Sussex, though optimistic, are unfortunately incorrect.

No work of this nature could possibly be complete, in the strict sense of the word, unless expanded into many volumes, and had the scope been a little less ambitious, the result would probably have proved far more satisfactory. The biographies could well have been dispensed with, similarly many of the definitions of the more complex chemical compounds, and thus space made available for the inclusion of many terms used in drilling, for example, which are unintelligible to the average non-technical man.

(3) The object of Mr. Joseph Pogue's book is to present, in perspective, the more important economic facts relating to petroleum, and it must be said that the author has certainly achieved his aim. He had every opportunity of producing an enormous compilation of statistics, relieved by a few terse, explanatory paragraphs and deductions, a veritable "blue-book" in fact, dreary, lifeless, and incomprehensible, as publications of that nature are usually wont to be. Instead, the author has given us a work of tangible value, one which seeks only to use past and present facts in order to foreshadow future possibilities.

People to-day are very apt to take things in general, and the petroleum industry in particular, for granted, and ignoring such factors as gradual and universal decline of oil production, more especially in the United States, they are blind to the economic situation which must inevitably be faced. Not only that, they are content to consume oil-fuel and allied products on a peculiarly wasteful scale at the present time, in a manner as complacent as it is incomprehensible to the careful thinker. We recognise in this the basis of Mr. Pogue's book. He says, "The point to be emphasized is the coming necessity for increasing the over-all efficiency of petroleum . . .", and having read that and other important observations made in his excellent preface, we are not surprised at the skilful manner in which he handles his ramified subject. The volume is very readable: indeed, it demands most careful perusal as it takes the reader rapidly from one aspect to another. Beginning with the economic organisation of the industry, it sets before us the salient features of the present trend of oil-field development, oil refinery practice, oil marketing, finance and the bearing of automotive transport on the industry, among other factors, while the chapters on resource situation, international aspects of petroleum, the full utilisation of petroleum, and the

function of statistics in the industry, are especially good.

In the space at our disposal, it is impossible to review a work of this nature with justice, and likewise to indulge in that amount of constructive criticism otherwise desired; we would suggest that, in view of its importance as an ultimate source of fuel, considerably more space be devoted to the oil-shale question in future editions, while present refinery practice might with advantage be much more severely criticised, both with regard to technique and design. The author is to be congratulated on the achievement of a remarkably fine work, one that should be widely read by all serious servants of a great industry. H. B. MILNER.

Our Bookshelf.

Memoirs of the Geological Survey. Special Reports on the Mineral Resources of Great Britain. Vol. 20: *Lead and Zinc. The Mining District of North Cardiganshire and West Montgomeryshire.* By Dr. O. T. Jones. Pp. vi+207. (London: H.M. Stationery Office, 1922.) 7s. net.

LIKE the three previous volumes dealing with British lead and zinc ores which have been issued by the Geological Survey, it must be admitted regretfully that the present one has a scientific rather than an economic interest. Some of the mines described in the present volume, like Frongoch mine in Cardiganshire and the Van mine in Montgomeryshire, have been extraordinarily productive; the former has been worked for 59 years and the latter for 51 years, and from each more than 100,000 tons of lead and zinc ores have been produced in the course of its career, but in both cases the really productive period was something like half a century ago. The author suggests that it is just possible that these mines might show an improvement by sinking deeper and reaching harder rocks than the soft shales in which they are now bottomed; the prospect, however, is not a very promising one, and the present low price of lead affords no encouragement to spend money on prospecting operations of a highly speculative nature.

The real value of the present work lies in the excellent study of the formation of the faults and fissures and the mode of their filling which Prof. Jones has supplied in the introductory chapters. The first chapter on the general structure of the area gives a very valuable summary of its leading geological features, while the next two chapters are devoted to a discussion of the leading system of fissures to which the district owes its mineral wealth. Finally, the last chapter deals with a number of important points such as the probable age and sources of origin of the ore filling, and the influence upon it of the country rock traversed by the fissures. These chapters form a most valuable contribution to the study of mineral deposition, and from this point of view, quite apart from any possible remote economic possibilities, Prof. Jones's volume deserves the careful attention of the student of mineral deposits. H. L.

Some Scottish Breeding Duck: Their Arrival and Dispersal. By Evelyn V. Baxter and Leonora J. Rintoul. Pp. vii+90. (Edinburgh: Oliver and Boyd, 1922.) 5s. net.

THE problems of the increase and extension of range of ducks in Scotland, and in other countries, have long exercised ornithologists throughout the British Isles. As the authors of the volume under notice point out, protection and a better feeling towards and a greater interest in all wild birds are probably important factors in the case but do not explain everything. Certain species other than ducks are as steadily decreasing, and the rise and fall of a species is a complicated biological problem which may have but indirect association with human interference, or may be due entirely to other causes. The recent colonisation of Scotland by other birds, such as the starling, turtle-dove, and great-crested grebe, may be due to the necessity for an over-abundant species to find new areas and the possibilities of settling in an area where raptorial birds and other enemies have been largely destroyed by man's advance and action.

One factor the authors have not stressed, the growing habit of keeping pinioned ornamental fowl, though they mention bird sanctuaries. Passing birds are often "called down" by pinioned fowl, and some of them may elect to mate and breed. That the direction of spread differs in such ducks as the gadwall and wigeon is no argument against this fact, for the source whence come the visitors has no bearing on the influences which cause them to remain. Many pairs of ducks of various kinds have probably nested in out-of-the-way places for years and been overlooked, for it is only within the last thirty years or so that parts of Scotland have been systematically explored from the ornithological point of view. Sportsmen and keepers are not very particular about the species of the ducks which fill their bags.

We note that the authors use the correct spelling of two much-discussed names, wigeon and shoveler.

An Introduction to Engineering Drawing. By J. Duncan. (Life and Work Series.) Pp. x+158. (London: Macmillan and Co., Ltd., 1922.) 4s.

THE aim of Mr. Duncan's book is to enable young students of engineering to produce intelligible working drawings of the details of engineering machines and structures. The student is introduced to the proper workmanlike methods of actual engineering practice, and is not allowed the use of any special hybrid methods which are supposed by many to be sufficient for use in schools.

The book commences with a description of drawing instruments, their use and handling; from this, the student is led to the ordinary problems in plain geometry with practical engineering examples such as drawing cams, and plotting small surveys. Afterwards, a little solid geometry introduces the student to oblique and isometric projection, and prepares him for the drawing of engineering details. For this latter portion of the training the author strongly recommends the use of models. A commencement is made with simple fastenings such as bolts and nuts, then the more complicated connexions are dealt with, as exemplified

in tie bar joints, cotter joints, and coupling boxes. The following chapters deal in succession with other engineering details, such as belt and rope pulleys, chain drives including sprocket wheels, bearings of various kinds, and details of shafting, cylinders, and pistons. Finally, structural details involving the usual angles, tees, and channels with the more elaborate columns, girders, and roof truss joints in which the sections are employed give the student a useful introduction to this side of engineering practice.

The book covers much ground in its 158 pages. It is very clearly written, and the publishers' part, in so far as concerns the type and diagrams, is quite perfect. For the purpose of familiarising the budding engineer with the elements of machines and structures the author has produced a most excellent book.

Juvenile Delinquency. By Henry Herbert Goddard. Pp. vi+120. (London: Kegan Paul and Co., Ltd., n.d.) 3*s*. 6*d*. net.

No student of modern life can fail to be perturbed by the number of juveniles who come before the courts yearly for offences covering a very wide range. That our present system does not deal with them adequately is obvious.

Delinquent behaviour is fundamentally unsocial behaviour, *i.e.* the child is obeying his own instincts instead of modifying them according to the demands of society. It becomes therefore necessary to ask why a child behaves unsocially. These unsocially behaved children fall into at least two groups, (*a*) those who are mentally too unintelligent to understand social behaviour; and (*b*) those known as psychopaths, who, while having normal intelligence, have not normal control.

The author suggests that these children should be cared for by some bureau organised by the State, which should undertake research work, be able to diagnose cases before the behaviour has become seriously wrong, and also to control the lives of those who will never be able to control them for themselves. He describes in this connexion the Ohio Bureau of Juvenile Research which, although only established in 1914, has yet justified itself by its work.

Outwitting our Nerves: A Primer of Psychotherapy. By Dr. Josephine A. Jackson and Helen M. Salisbury. Pp. viii+403. (London: Kegan Paul and Co., Ltd., n.d.) 7*s*. 6*d*. net.

THE stream of books concerned with explanations of modern psychologists in general, and of Freud in particular, for people of little or no psychological knowledge, still flows on. Many fail entirely in their avowed object, being either too condensed to be intelligible, or too popular to be scientific. The effect of a conversion to Freudian doctrines is, only too frequently, of the nature of a wholly uncritical acceptance of much that Freud would call problematical. It is therefore a relief to turn to this book, which not only gives a very fair and balanced account of the findings of psycho-analysis, but also keeps these findings in perspective, showing them in relation to the known laws of biology and psychology. The whole book is characterised by a sense of humour foreign to many writers on the subject, and by sanity of outlook. Written in an easy and popular style it can be safely recommended to the student of, or sufferer from, "nerves," and even to the reader already cognisant with the literature of psycho-analysis it will prove helpful and interesting.

Imperial Institute: Monographs on Mineral Resources with Special Reference to the British Empire: Silver Ores. By Dr. H. B. Cronshaw. Pp. ix+152. (London: John Murray, 1921.) 6*s*. net.

THIS addition to the useful Imperial Institute Monographs gives details and statistics of the sources of silver throughout the world. In 1918 the British Empire produced nearly one-fifth of the world's supply, Canada being responsible for the larger part of this amount. The United States headed the list of producers during the war period, but has now been passed again by Mexico. About two-thirds of the world's silver comes from base metal ores, and much of the remainder is obtained from ores worked primarily for gold, so that silver is mainly a by-product of other metallurgical operations. The extraction and uses of silver are dealt with only very briefly in this monograph, and some information as to the metallurgical processes employed in the most important mining regions would have added to its value. This remark applies particularly to the account of the rich and metallurgically interesting Cobalt district of Ontario, which is responsible for the greater part of the Canadian production. These monographs provide much information in a handy form.

A Systematic Qualitative Chemical Analysis: A Theoretical and Practical Study of Analytical Reactions of the more Common Ions of Inorganic Substances. By Prof. G. W. Sears. Pp. vi+119. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1922.) 8*s*. 6*d*. net.

THE introductory part of the work under notice contains a brief account of such matters as equilibrium, ionisation, and solubility product. The section on the detection and separation of the metals is in the form of numbered experiments, and is much less clear and useful than the usual arrangement in tables. The explanations of the reactions, however, are very clearly and fully described, and would be useful in supplementing analysis tables. The section on acids relies on precipitation methods with a single sample, and all preliminary tests are omitted. This seems to be a mistake, as many acids are readily found by simple preliminary methods. There appear to be no features which would indicate any marked superiority of the book over existing treatises.

An Introduction to the Chemistry of Radio-Active Substances. By Dr. A. S. Russell. Pp. xi+173. (London: J. Murray, 1922.) 6*s*. net.

THERE is at present a real need for a small but up-to-date book on radioactivity, in which the subject is dealt with from the chemical as well as the physical side. Dr. Russell's book would seem to supply this need very satisfactorily. It is not overburdened with detail, but gives a balanced account of the subject, which will be found very useful to students. A particularly good feature is the inclusion of the chemical methods of separation and analysis, which sometimes tend to get lost in theoretical speculations.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Dampier's "Discourse of the Winds" and the Distribution of Wind on the Earth's Surface.

DAMPIER'S "Voyages" are well known, at any rate by name, but his "Discourse of the Winds" is seldom referred to. It is, however, well worth careful examination and, so far as I can judge, contains as much information about the distribution of winds as any of the modern works on the same subject.

In this "Discourse" Dampier propounds no theories, but aims at setting down the general character of the winds encountered by ships in all parts of the world, using for this purpose his own observations, and such other information as he has gathered from sources which he considers trustworthy.

It must be remembered that in Dampier's time (late seventeenth and early eighteenth centuries), the ships employed even for the longest voyages were small, and the direction and strength of the prevailing winds were much more important to navigators than they are at the present time. It is true that there are still plenty of small sailing craft in various parts of the world, the captains of which are probably well acquainted with local conditions, but these men as a rule are not of the type who place their knowledge on record. With the "Discourse" Dampier publishes maps of the hemispheres in which his observations are summarised.

For his purposes he divides the earth's surface into four regions, namely, the two trade wind areas and those to the north and south of them. These latter he calls the "Regions of Variable Winds." The directions of the trades are indicated in the maps by lines and arrows, but naturally and rightly the regions of variable winds are left blank.

No indication is given of the directions of the wind on land, but what he calls coastal winds, that is winds the direction of which is influenced by the proximity of land, are shown in some detail.

Parts of the maps are here reproduced (on the original scale) which show that "coastal" influence in the trade wind areas extends farther to the west (*i.e.* to leeward) of the continents than to the east.

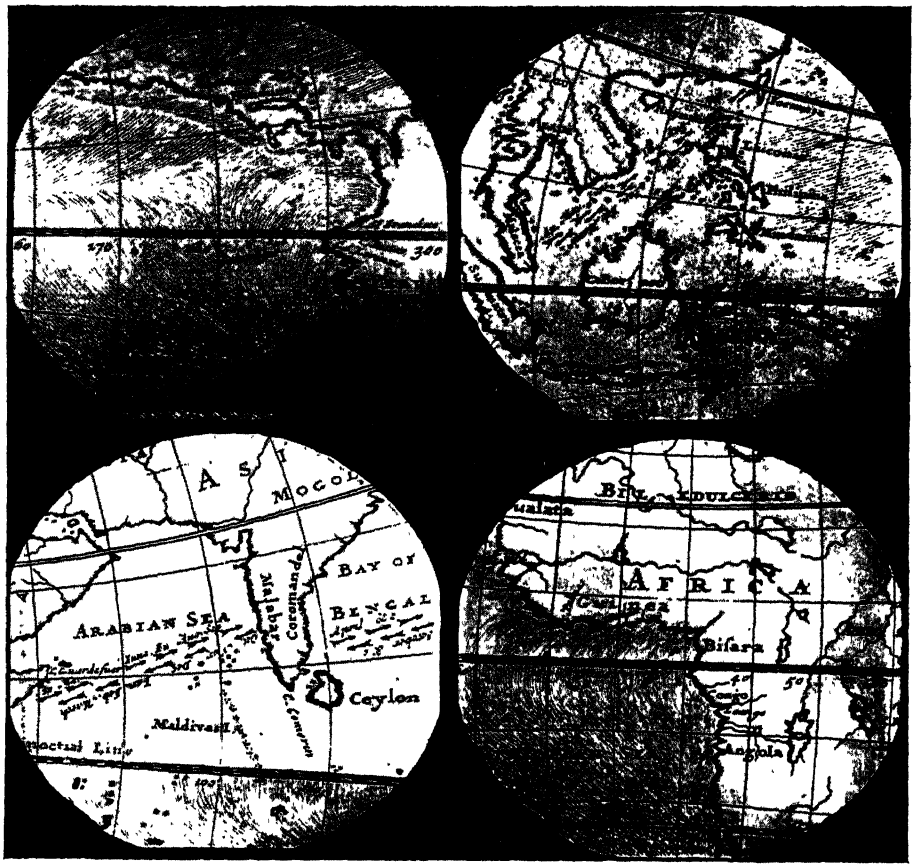

FIG. 1.—Reproduction of parts of Dampier's Maps to show coastal winds in the Trade wind areas.

Although it is impossible to determine *a priori* what the true wind should be at any given spot, it is not without interest to consider what would happen in certain imaginable conditions much simpler than those actually existing, and to see whether in such conditions the air currents, etc., would at all resemble those which are observed.

Starting with the earth as the only body in the universe, without rotation, and at a temperature of absolute zero, let its surface be uniform and level, and let its volume and that of adjacent space be divided into elementary conical cells proceeding from the earth's centre. Let the walls of the cells be non-conductors of heat but transparent to radiation.

Now let this earth be warmed by a source of heat equivalent to the sun, but in the form of a distant ring surrounding it in the plane of the equator. Let the atmosphere be transparent to radiation and take its heat only from the floor of the cell which contains it.

In the course of time the contents of each cell will reach the temperature of the floor, which will be a maximum at the equator, and will vary as the cosine of the latitude to absolute zero at the poles.

The barometric pressure in each cell will be the same; were all the cells removed the atmosphere would be in equilibrium. The equilibrium, however, would be unstable, and the least departure from the original stratification of density would cause ultimately a circulation to be set up, in which, in the absence of turbulence, warm air would flow from the equator towards the poles at high levels, while cooled air would travel in the opposite direction near the surface of the earth. A steady distribution of temperature would be reached when each element of the surface lost by radiation as much heat as it received from the source plus that supplied by the circulation, and this distribution probably would not differ much from that which now exists, though the fact that the real atmosphere is more or less opaque to long waves would introduce a sort of "green-house" effect, and raise the mean temperature above that appropriate to perfect transparency. Again if the imaginary earth were completely covered by a deep ocean, a separate circulation would be set up in the latter, and the temperature distribution would be somewhat modified in the direction of greater uniformity.

Since the energy of the circulation is derived from the source of heat, there will be no change of pressure due to the velocity, and supposing for the moment that the air is incompressible, then in the nearly horizontal path which constitutes the greater part of each stream line circuit, the cross-section velocity and dynamic head for each will be constant, though not necessarily the same for different streams. The cross section of the ascending and descending parts of the streams will bear to the cross section of the horizontal part the ratio of the length of the earth's quadrant to the height of the homogeneous atmosphere, and thus in the neighbourhood of the poles and the equator there will be a small increase of pressure. The form of the stream lines due to temperature circulation in a spherical shell is indicated diagrammatically in Fig. 2.

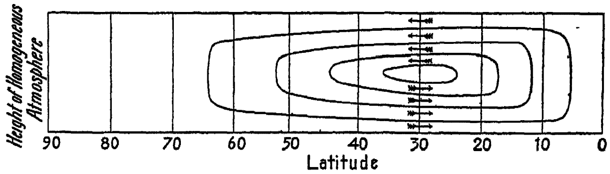

FIG. 2.—Stream lines of the circulation in a meridional element of a spherical shell, the density of the fluid being supposed constant.

As regards the distribution of temperature, the results would be much the same whether the earth were stationary or rotating, but the direction and velocity of the wind referred to a fixed point on the solid surface would be very different in the two cases. If, in the absence of surface friction, the earth were given its present angular velocity the apparent wind would have an easterly component of about 1000 miles per hour at the equator while at the poles there would be a calm. If, on the other hand, when the rotation was started, the air was given the same velocity as the surface under it, the apparent wind would vary in direction and force in a period equal to that of the circulation.

In the real atmosphere, the effects of turbulence, viscosity, and surface friction will ensure that the average velocity of the apparent wind shall in no place exceed 30 or 40 miles per hour. If unresisted air passes from lat. λ to $\lambda \pm \Delta\lambda$ the change of the linear speed of the ground under it, *i.e.* the change in the E. or W. component of the apparent wind, is $R\Delta\lambda(1-\sin\lambda)$ linear velocity in longitude, and if the apparent wind remains constant, it shows that surface friction is sufficient to accelerate or retard the atmosphere by this amount in the time taken in covering the distance $R\Delta\lambda$. In the case of the earth, this would imply that if the circulating velocity (*i.e.* the N. or S. component) is 15 m.p.h., surface friction suffices to change the speed of the apparent wind by about 15 m.p.h. per hour near the poles while in lat. 30° the corresponding change would be somewhat less than 2 m.p.h. per hour.

On the imaginary seasonless earth, the average wind would everywhere be a definite function of the latitude and coefficient of friction, provided that the going and returning parts of the circulation did not mix on the journey, and in low latitudes this would be true even when the effects of turbulence were taken into account. Farther north or south, however, the hot and cold streams would become interwoven in eddies the forms of which are incalculable, though the average winds would always be either from N. and E. or S. and W. Thus it might be expected that there

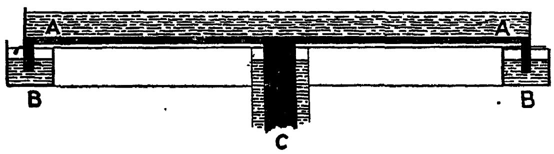

FIG. 3.—AA, Circular conducting plate and tank. BB, Annular hot water trough. C, Axis and cold-water tank.

would be calms at the equator, moderate and regular trade winds for some distance on either side, and beyond these, irregular winds, the intensity of which increased with the latitude. The barometric pressure would be nearly constant except in the eddies, and there the variation of pressure would depend, not on the actual velocity of the apparent wind, but on its difference from the average for the latitude.

Such a description with modification depending on the seasons, the presence of moisture in the air, and on the distribution of land and water agrees with the average conditions on the real earth. Dampier's maps show that coastal influence may be sensible through 10° of longitude or more, and it may be guessed that the direction of the monsoons is in some way influenced by the great area of land lying to the north of the parts where they blow.

There is not much information available concerning the wind structure of the atmosphere on the borders of the Trades, and a proper investigation of this subject would form an important addition to meteorological science; but such an investigation would require more than one *Challenger* expedition devoted to the exploration of the upper air instead of the deep sea.

Expeditions of this kind are not likely to be undertaken at the present time, but some notion of the manner in which the Trades break up might be gained by an experiment such as is indicated in Fig. 3, where a thick circular metal plate, provided with descending flanges at the circumference and a thick central axis, carries a shallow circular tank containing fluid. The flanges dip into a circular trough of warm water while the axis is kept cold. If the apparatus is stationary, a circulation is set up in the tank of the type shown in Fig. 2, but if it has an appropriate angular speed about the axis, the

conditions will have a certain similarity to those existing in the atmosphere. The difference in the character of the circulation in the two cases could scarcely fail to give some useful hints.

Another illustration of the kind of flow to be expected near the borders of the Trades may be observed (although the analogy is not so close as in the experiment) whenever a current of water flows into a pond. The central part of the stream continues on its course for some distance unbroken, but the margins are bordered by eddies, which (looking down stream) are right-handed on the right, and left-handed on the left side, and consist of equal volumes of water from the stream and from the pond wrapped together after the fashion of a "roly-poly" pudding. When once formed, they have a certain life of their own, and follow erratic courses, often generating secondary eddies further from the main stream. In general their life is short, but occasionally vertical components in the flow of the main stream give rise to components in the eddies parallel to their axes, and in such cases the vortices may be sustained and intensified.

Much the same sort of action must be going on at the borders of atmospheric currents, and it must happen, especially in the turbulent regions, that either on account of the general circulation or from local causes, warm air will sometimes underlie colder strata, and this is what is required to prolong the life of eddies or vortices with vertical axes.

It may be said with some confidence that tornadoes, sand pillars, and waterspouts are due to local causes of this kind, and it seems highly probable that the deep barometric depressions which accompany the greater storms have a similar origin depending on inversions of level of the general circulation. In referring to warm and cold strata, the temperature must be supposed to be compared at the same altitude since, so far as thermometric readings are concerned, the upper air is always colder than that near the ground.

A. MALLOCK.

9 Baring Crescent, Exeter,
August 10.

The Conditions of Sex-change in the Oyster (*Ostrea edulis*).

IN the issue of NATURE for August 12, p. 212, and in several previous numbers, Dr. Orton has given some interesting information concerning the old question of the breeding habits of oysters, especially sex-change and its conditions. This problem has been discussed in a certain number of ancient treatises (Davaine, Van Beneden, Lacaze-Duthiers, Hoek, etc.), but has been but little investigated in the course of the last few years. During my work at the Danish Biological Station I have, since 1919, been making experiments and investigations on the biology of the oyster in the Limfjord. As my results in several respects confirm and amplify those of Dr. Orton, I will give here a short account of some of the most important. In the course of the winter a more detailed paper will probably be published in the Report of the Danish Biological Station.

Dr. Orton confirms the observation, made by Möbius, that in European oysters a specimen directly after breeding produces spermatozoa, and I fully agree with him. In several cases I have proved, through experiments with oysters, in the shells of which a little hole had been bored, that an oyster in the course of less than a week changes from a female to a male.

Dr. Orton further mentions the interesting fact that he has been able to state that an oyster born in 1921 was spawning already in 1922; this phenomenon he ascribes, and very rightly, to the high temperature of the summer 1921. I have investigated several thousand oysters in the Limfjord: the youngest female found by me was at least three years old, which is no doubt due to the lower temperature of the Limfjord. Neither did I ever find that oysters had ripe spermatozoa in the summer in which they were born; in the Limfjord that phenomenon only occurs in the following summer. Formerly the earliest time for an oyster to breed was much discussed. If we examine from where the different authors have obtained their material, it appears that those who advocated early breeding had got theirs from Southern France, while those who advocated two to three years as the age for breeding had had material from the English Channel and the North Sea.

From my experiments, and from the study of previous papers on this subject, I have come to the conclusion that the duration of the male stage depends on temperature, so that the colder it is the longer the stage lasts. At the temperature which ordinarily prevails in the Limfjord (15°-16° in July), this stage will last three to four years. The oyster, therefore, breeds for the first time (the first stage being the male stage) when it is three to four years old; further, every single oyster individual in ordinary circumstances of temperature breeds only every third or fourth year, in especially cold years still less often, in warm years more often. These phenomena, together with the shorter duration of the female stage, explain the fact that in a certain number of oysters in the Limfjord we always find only a relatively small percentage of females. This likewise explains why the oyster breeds more sparingly the further north it is, and decreases regularly in number without any sharp boundary-line.

The breeding of the oyster is in at least three respects influenced by temperature. A high temperature increases the number of times an oyster may breed in its life, it shortens the time which the breed passes in the mantlecave of the mother animal, and, according to Hagmeier, it shortens the pelagic larva stage.

R. SPÄRCK.

Copenhagen, September 5, 1922.

Rise in Temperature of Living Plant Tissue when infected by Parasitic Fungus.

WHILE engaged on some work connected with the export of citrus fruits from South Africa to England, we have come across a point of interest to plant pathologists and bacteriologists which would seem worth recording at this stage.

In investigating the effects of inoculating oranges and grapefruit with *Penicillium digitatum* we found that a very definite rise of temperature took place in the infected tissue. We are not aware of such an observation having been made before in connexion with the invasion of plant tissue by a parasitic fungus, and it will be interesting to ascertain whether a similar rise of temperature takes place in all cases where living plant tissue is attacked by parasitic fungi or bacteria.

To what extent direct reaction of the host is responsible for the rise of temperature is still to be determined; certainly no rise of temperature was observed when the host tissue was killed prior to inoculation. Mercury-in-glass thermometers were used in making these observations, but the employment of thermo-electric apparatus will naturally be necessary to carry the investigations further.

This observation of ours would seem to open up

an entirely new field for research by botanists, and it is probable that it may have an important bearing on the problem of fruit and vegetable transport and storage.

An account of the experiments undertaken to illustrate the above will be published in due course.

I. B. POLE EVANS.
MARY POLE EVANS.

Office of the High Commissioner for the Union of South Africa,
Trafalgar Square, London, September 22.

Coral in Medicine.

IN the serious contributions published in recent issues of NATURE on the subject of black coral, no one seems to have remembered that in the "Médicin malgré lui" Molière makes Sganarelle offer a medicinal cheese to Perrin for his mother, thus:

P. Du fromage, monsieur?

S. Oui; c'est un fromage préparé, où il entre de l'or, du corail et des perles, et quantité d'autres choses précieuses.

And Sganarelle's last words are, "Si elle meurt, ne manquez pas de la faire enterrer du mieux que vous pourrez."

F. JEFFREY BELL.

September 20.

Biography of Sir Norman Lockyer.

MISS LOCKYER and I are preparing a biography of my husband, Sir Norman Lockyer, in a form which I hope will make it not only of interest to his many friends and admirers, but also a contribution to the scientific literature of the present day. If any readers of NATURE happen to possess letters from my husband, I should be greatly obliged if they would give me the opportunity of seeing them. My object in making this request is that any matters of general interest which thereby come to light might be incorporated in the work.

The letters would not be quoted, except with the permission of their owners, and would be returned as soon as their contents had been noted.

T. MARY LOCKYER.

Salcombe Regis, Sidmouth,
September 22.

Harpoons under Peat at Holderness, Yorks.

AT the recent meeting of the British Association at Hull there was a very lively discussion at Section H about some harpoons said to have been found under peat in Holderness. May I ask you to be so good as to spare a little space, in order that I may say more fully what time prevented me from saying then?

There is a doubt about the authenticity of those harpoons. Mr. T. Sheppard believes them to have been *made* by the supposed finder; Mr. A. L. Armstrong, who introduced them to the meeting, believes them to be genuine. I also believe one of them to be genuine, the smaller of the two; about the other I am not so sure. But I expressed no opinion as to whether, if genuine, they were found locally or not, since I have no means of forming an opinion. It is possible that they—or the smaller of the two—were found in archæological excavations abroad; and a fictitious site in Yorkshire given to them later to enhance their interest.

Mr. Sheppard quite rightly says that the discovery of a flint axe of a certain type "in the neighbourhood" proves nothing. But I understood that it was found under a depth of peat. In type it is Campignian, exactly what one would expect to find associated with harpoons of early neolithic type.

There can be little doubt that in Holderness exist remains of the early neolithic age, remains which are older than the Long Barrows. Apart from surface-finds, the pile-dwellings or platforms at Ulrome are evidence of the existence of habitations there which seem to be neolithic; they contained stag's-horn axes of a well-known early neolithic type—though it is true that type survived right through the neolithic period on the continent. There is thus no *a priori* reason for rejecting the harpoons; they are just what I have always expected would be found in Holderness.

However, we cannot use suspect material as evidence, and the best thing to do is to go into the field and test it. If Mr. Armstrong will find a site where flint flakes and implements are to be found under the peat in sufficient numbers to justify digging, I will come and bring a spade with me.

O. G. S. CRAWFORD.

Ordnance Survey Office, Southampton,
September 18.

A Curious Luminous Phenomenon.

I HESITATE to trespass on your space in describing an observation which may be more common than I suppose.

While standing about twenty yards from the sea-shore and looking due south out to sea, the horizon and a region slightly above it (elevation only about 1° or 2°) were lit up by a faint white light which extended laterally over a segment subtending an angle of about 30°.

The conditions under which this light was seen were as follows: Time, 7.15 P.M.; wind strong from the west, bringing up a good deal of low cloud and very fine rain in the air causing bad visibility; sea rather rough with four lines of breakers at the shore. The appearances of the light were not the same to my wife as to myself. Her impression of it was that it was a light which she saw only if her eyes followed it, yet it consisted of a long streak of light parallel to the horizon with a break in it and then another small streak. My impression was that of a light which appeared to flash up over the horizon, subtending the angles already noted, the flashes not succeeding each other regularly. I had the feeling that my eyes had to be just right for getting the impression at all.

As to the cause, I think we can eliminate that of distant lightning; the weather had not been for many days of a thundery type, and it is unlikely that distant flashes would light up a streak of the distant sky embracing such a wide lateral angle and yet be restricted to an elevation of not more than 2°.

The sky above the horizon was darkly and uniformly clouded at the time, so that the horizon was barely visible, but white-capped waves could be seen far out at sea. The brightest objects in the field of view were the lines of breakers at the shore, and it may be that the retinal images of these being very near to that of the horizon were the cause of the phenomenon. Perhaps some readers of NATURE are familiar with this sort of observation and will point to the obvious cause.

S. R.

Aldwick, Sussex,
September 16.

A Fifty-foot Interferometer Telescope.[1]

By Dr. GEORGE E. HALE, For.Mem.R.S.

THE angular diameter of a star was measured for the first time by Mr. Francis G. Pease at the Mount Wilson Observatory on December 13, 1920, with a 20-foot Michelson interferometer attached to the 100-inch reflecting telescope. The method employed is due to Prof. Michelson, who had adjusted the interferometer and tested it on stars during the previous summer, with the assistance of Mr. Pease. Since that time Mr. Pease has measured the diameters of Betelgeuse, Arcturus, Aldebaran, and Antares. On the basis of the best available values of their parallaxes, the corresponding linear diameters are 215,000,000, 21,000,000, 270,000,000, and 400,000,000 miles respectively. These stars are all in the giant stage, with densities ranging from 0·000001 (Antares) to 0·0002 (Arcturus). The Sun, a dwarf star 866,000 miles in diameter, in a much more advanced state of development, has a density of 1·4 (water = 1).

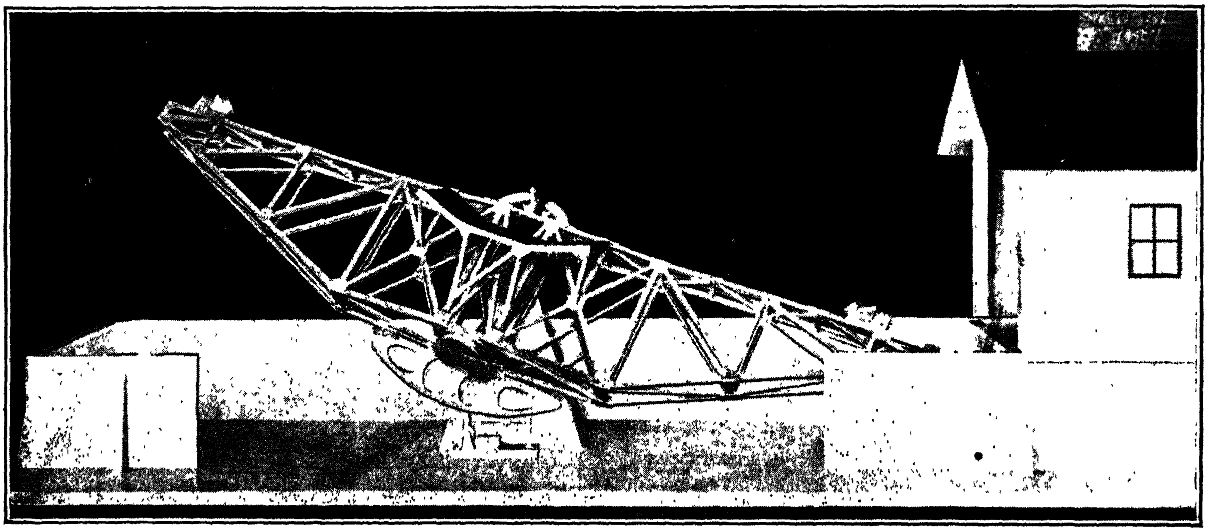

FIG. 1.—50-foot interferometer telescope for the Mount Wilson Observatory.
Model seen from the north (part of wall removed to show 36-inch mirror cell and driving mechanism).

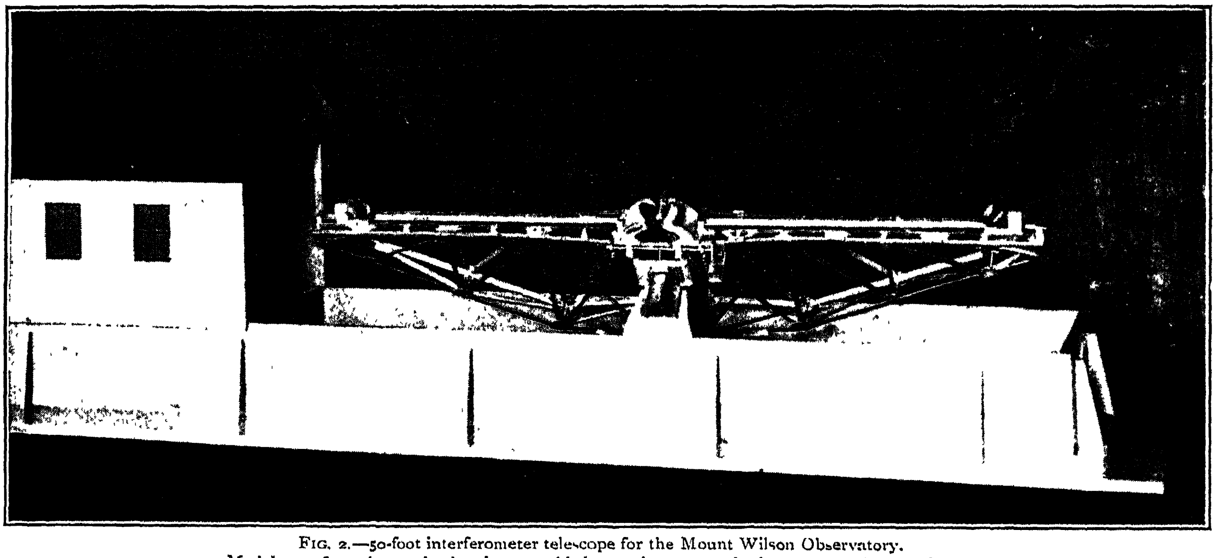

FIG. 2.—50-foot interferometer telescope for the Mount Wilson Observatory.
Model seen from the south, showing movable house that covers the instrument when not in use.

It would evidently be of great interest to measure the diameters of other stars, of various spectral types, because of the direct bearing of the results on the problem of stellar evolution. Unfortunately, very few are within the range of the 20-foot interferometer, and neither the capacity of the telescope mounting nor the width of the observing aperture in the dome will permit a larger instrument to be used with the 100-inch re-

[1] The substance of this article was communicated to Section A of the British Association at Hull on Monday, Sept. 11, by Prof. H. H. Turner, who showed the photographs of the model on the screen.

flector. Immediately after the first successful measures by Mr. Pease, both he and I made several designs of large interferometers with independent equatorial mountings, but their cost would have been too great to warrant their construction. It was also thought advisable to postpone further instrumental developments until they could be undertaken in the light of prolonged experience with the 20-foot interferometer.

The method has since proved so successful, and its wider application so desirable, that the mechanical problem has recently been taken up anew. Optically the 20-foot instrument leaves nothing to be desired. The new instrument is therefore simply a larger Michelson stellar interferometer adapted for the observation of fainter and smaller stars, embodying no new optical features, but carried by a mounting so simplified in design as to reduce the cost of construction to a minimum. My specifications for the mounting, which have been improved in certain respects and developed into working drawings by Mr. Pease and his associates in the Division of Instrument Design of the Mount Wilson Observatory, call for a light but very rigid skeleton girder about 54 feet long and 10 feet deep at its centre, where its cross-section is about 4½ feet (Figs. 1 and 2). This is to be built of standard steel shapes, cut to length at the mill and riveted together on Mount Wilson. The girder will be bolted to a heavy plate carried by the upper extremity of the polar axis, which is a short steel forging turning in standard roller bearings, mounted on the upper face of a massive concrete pier. The polar axis passes through the centre of gravity of the girder, thus assuring its balance in all positions. A worm-gear sector of long radius, bolted to the girder, is driven by a worm connected with a driving-clock fixed near the north face of the pier. The range of motion in right ascension is 1½ hours east and west, thus allowing ample time for the observation of a star when near its meridian passage.

The optical parts comprise a paraboloidal mirror of 36 inches aperture and about 15 feet focal length, mounted within the girder, as shown in the illustrations. The two outer plane mirrors, each 15 inches in diameter, mounted at 45° on carriages which slide along rails bolted to the upper face of the girder, receive light from the star and reflect it to two similar 45° plane mirrors, fixed in position above the 36-inch mirror, to which they send the two parallel beams. These are returned as converging beams toward the focus, but are intercepted by a (Newtonian) 45° plane mirror above the centre of the girder, which sends the light to the focal plane, in the direction of the north pole. The observer, seated on a platform carried by the girder, makes the necessary adjustments and determines the visibility of the interference fringes corresponding to various settings of the outer 45° mirrors, which are periodically moved apart by a single long screw driven by an electric motor. The distance between these mirrors, when the fringes disappear completely, gives the angular diameter of the star if the mean wave-length of its light is known.

To reach stars north or south of the equator, the two outer 45° mirrors are rotated simultaneously by synchronous motors about the axis joining their centres. In this way any star from the pole to 30° south declination can be observed when near the meridian.

Throughout the design precautions have been taken to reduce the amount of large and expensive machine work to a minimum. The girder need be only approximately straight, as the rails, carefully planed in 12-foot lengths (the limit of our planer bed), will be optically lined up by adjusting screws. The final compensation for length of path will be effected by a sliding wedge, of the type designed by Prof. Michelson for the 20-foot interferometer. Comparison fringes, adjustable for visibility, will be provided as an aid to the observer. The instrument will be covered when not in use by a sheet steel house with double walls, the upper part of which can be rolled away longitudinally by an electric motor.

This interferometer should permit the measurement of more than thirty stars brighter than the fourth magnitude, representing a wide range of spectral types. It is now under construction in the instrument and optical shops of the Mount Wilson Observatory.[2]

[2] For a brief account of the 20-foot interferometer and its method of operation, see the chapter on "Giant Stars" in the writer's recent book "The New Heavens," reviewed in NATURE of July 11, p. 2. Full details are given by Messrs. Michelson, Pease, and Anderson in the *Astrophysical Journal.*

Motorless or Wind Flight.

By Dr. S. BRODETSKY.

RECENT achievements in motorless flight, variously designated as *gliding*, *soaring*, and *sailing*, have attracted considerable attention, and much discussion has arisen as to the practical and military value of this new development, as well as to its scientific significance. While many authorities anticipate nothing more than the emergence of a new "sport," and ascribe little importance to motorless flights, others of a more imaginative turn of mind foresee great possibilities in this type of aerial navigation. The motorless flying machine has even been proclaimed as heralding the doom of the engine-driven aeroplane!

It is certainly premature to attempt a forecast of the future of flight in a glider. The art of gliding is, of course, older than that of flight in an engine-driven machine: Lilienthal's experiments with gliders were made more than a generation ago, long before any aeroplane containing a motor rose into the air and executed a real flight. But Lilienthal, Pilcher, Chanute, Orville Wright, and others were not able to stay aloft in a glider more than a few minutes; whereas during the recent competitions in Germany, Martens remained in the air nearly three-quarters of an hour, and Hentzen stayed in the air two hours, and later three hours, performing evolutions of an intricate character. It is therefore clear that the art of gliding has entered upon a new phase, and the scientific problems involved merit careful discussion.

As already indicated, there is considerable diversity in the names given to the flights thus carried out

without the aid of a motor. All the three names mentioned above are really unsuitable. The term gliding is reminiscent of descent in an aeroplane, while the real interest of recent events has been in the fact that pilots were able to stay in the air very long without the help of a motor, and in fact performed climbing feats. The term soaring is less unsuitable, but it suggests climbing as the essential thing, whereas, in reality, horizontal flight in a glider is just as different from aeroplane flight as climbing in a glider. Finally, sailing is quite inappropriate as a description of the flight in question. Perhaps the term *wind-flight* is a really suitable name for flying without a motor, as distinguished from *engine-flight* in an aeroplane.

The wind is indeed the main instrument of motorless flight. Whether birds and other natural flyers do or do not derive energy from the air in some mysterious manner of which we have, as yet, no knowledge is a question that does not arise in the present connexion. The successes achieved have been the outcome of careful study of design and of movements in the air. In construction the gliders used look like aeroplanes without engines, and the determining factors in the flights were the various types of winds that blew while the machines were in the air.

It is clear that in a quiescent atmosphere the net result of any motion through the air in a motorless machine must be a diminution in the total energy, *i.e.* in the sum of the kinetic and potential energies. It follows that in the absence of wind, real flight, namely, flight in which the machine maintains its level for some considerable time, or rises still higher above the ground, is not possible without a source of energy like an engine. It is the presence of wind that puts in the hands of the pilot a source of energy, which can be used to neutralise the loss of energy involved in motion through the atmospheric resisting medium.

Although it should be obvious that the wind must be upwards or unsteady in order to supply this energy, it is necessary to say a few words about the case of a steady horizontal wind, since it has been claimed that "once the airman has left the ground he gets his energy from *the wind*, which may be level and steady." This is not correct, as can be proved quite simply. If we write down the equations of motion of a glider through the air under the action of gravity, we get three types of terms:

(1) Accelerations in terms of the motion of the glider relative to the earth;

(2) Gravity components;

(3) Forces and couples due to air resistance, these being functions of the motion of the glider relative to the air.

It is useful to write the first terms, the accelerations, with reference to the motion of the glider relative to the air. When this is done for a steady wind, the resulting equations are exactly of the same form as if there were no wind at all, since the moving "air axes" move uniformly as seen from the "earth axes." This means that when there is a steady wind, we get the actual motion of the glider as seen from the earth, by adding the velocity of the wind to the motion of the glider in still air; in other words, to an observer travelling with the wind, the motion of the glider would not reveal any effects that can be attributed to the steady wind.

In a horizontal steady wind, therefore, real flight is no more possible without an engine than in absolutely windless air. Any argument that leads to a contrary conclusion must have a fallacy somewhere, if we are to have any confidence in the principles upon which all our mechanics are based. It is true that a steady horizontal wind can be used as an aid in gliding. Thus, by pointing his machine into the wind the pilot can get off the ground with less initial speed than in still air. Further, when the machine is already in the air the pilot can, by pointing it with the wind, increase the horizontal distance travelled before reaching the ground again. But a steady horizontal wind cannot make the machine stay at the same level in the air for any length of time, or climb. For these purposes the wind must be upwards or variable.

If the wind is steady, but has an upward component, it helps in the attainment of real flight, which we can call wind-flight. Thus, if a glider is so constructed that in still air it performs a straight line glide with speed U at gliding angle θ below the horizontal, then a steady wind of speed U, blowing at an angle θ above the horizontal, will keep the glider suspended in the air indefinitely, if it points into the wind. And, more generally, if the steady wind has speed U' at an angle θ' above the horizontal, where $U' \sin \theta' = U \sin \theta$, then the machine will fly horizontally with speed $U \cos \theta - U' \cos \theta'$ relative to the earth, if it is given this speed initially against the wind. If $U' \sin \theta'$ is greater than $U \sin \theta$, so that the vertical component of the wind is greater than the rate of vertical fall of the glider in still air, then the glider will climb with horizontal speed $U \cos \theta - U' \cos \theta'$ and upward vertical speed $U' \sin \theta' - U \sin \theta$.

These results are simple and obvious. Given a steady wind with sufficient upward vertical component, a glider can perform real flights and make evolutions similar to those of ordinary aeroplane flight.

It is not necessary, however, to postulate steady upward wind. If the wind is variable, and this is, of course, usually the case, energy can be derived from the wind, even if it is horizontal, or downwards. This can be seen by a little analysis based on the ordinary equations of motion of the glider. Thus, suppose that the wind is in a straight line, but of varying speed. If we write the accelerations in these equations in terms of the motion relative to the air, we readily find that the motion of the glider relative to the air is the same as if the air were at rest, and a force per unit mass were given to the glider, in a direction opposite to that of the wind and proportional to the acceleration of the wind. If the wind rises steadily from zero to U' in time t, the motion of the glider is found by taking the air to be at rest and assuming that on each unit mass there acts, in addition to the weight, a force U'/gt in a direction opposite to the wind.

If, then, the machine is pointed into the rising wind, and the wind varies quickly enough, flying becomes possible. If the wind is being retarded, similar propulsive effect is obtained by pointing the machine with the wind. It follows that in a fairly sudden gust, which can be taken to consist of a quickly increasing

wind, followed by a quickly decreasing wind, the pilot can take advantage of both phases by pointing the machine into the rising wind, and with the falling wind. Quick manœuvring is, of course, essential, as well as an intimate acquaintance with the movements that are always taking place in the air.

With more complicated variations in the wind, more complex results are obtained. It is now clear, however, that the future of wind-flight is associated with three main lines of study:

(1) The motions that are continually taking place in the atmosphere need to be studied, not only the meteorological wind phenomena as ordinarily understood, but particularly the detailed air motions, the "internal structure of the wind."

(2) Motorless flight presents problems of design that are different from those of ordinary aeroplanes. This is because the glider is a much lighter machine than the aeroplane. Stability is essential, but easy control is a *sine qua non*, since so much depends upon taking as full advantage as possible of any temporary, and often unanticipated, motion in the air.

(3) The rigid dynamics of wind-flight is also an important factor in the progress of the art. Only in very exceptional circumstances can the motion of a glider be steady. Upward steady winds, or uniformly varying winds, are only of rare occurrence and brief duration, and in trying to perform real flight in an engineless machine the pilot must make use of any stray wind that comes to his aid. The motion in wind-flight must consequently be very variable. In this respect wind-flight must generally differ in essence from engine-flight. In the latter steady flight is the rule, in the former steady flight is bound to be a comparative rarity. The pilot must therefore learn from experience and from calculation to know what to expect from his machine under different conditions. The dynamics of wind-flight should be a fruitful subject of study both for the aviator and the mathematician.

The Influence of the late W. H. R. Rivers on the Development of Psychology in Great Britain.[1]

By CHARLES S. MYERS, C.B.E., M.A., M.D., Sc.D., F.R.S.

A MOURNFUL gloom has been cast over the proceedings of our newly born Section. Since its inauguration twelve months ago this Section, as, indeed, psychology in general, has suffered an irreparable loss through the sudden death, on June 4 last, of him who was to have presided here to-day. When, only a few weeks ago, it fell to me, as one of his first pupils, to occupy Rivers's place, I could think of little else than of him to whom I have owed so much in nearly thirty years of intimate friendship and invaluable advice; and I felt that it would be impossible for me then to prepare a presidential address to this Section on any other subject than on his life's work in psychology.

William Halse Rivers Rivers was born on March 12, 1864, at Luton, near Chatham, the eldest son of the Rev. H. F. Rivers, vicar of St. Faith's, Maidstone, and of Elizabeth, his wife, *née* Hunt. Many of his father's family had been officers in the Navy—a fact responsible, doubtless, for Rivers's love of sea voyages. The father of his paternal grandfather, Lieutenant W. T. Rivers, R.N., was that brave Lieutenant William Rivers, R.N., who, as a midshipman in the *Victory* at Trafalgar, was severely wounded in the mouth and had his left leg shot away at the very beginning of the action, in defence of Nelson or in trying to avenge the latter's mortal wound. So at least runs the family tradition; also according to which Nelson's last words to his surgeon were: "Take care of young Rivers." A maternal uncle of Rivers was Dr. James Hunt, who in 1863 founded and was the first President of the Anthropological Society, a precursor of the Royal Anthropological Institute, and from 1863 to 1866 at the meetings of this Association strove to obtain that recognition for anthropology as a distinct Subsection or Section which was successfully won for psychology by his nephew, who presided over us at the Bournemouth meeting in 1919, when we were merely a Subsection of Physiology.

Our "young Rivers" gave his first lecture at the age of twelve, at a debating society of his father's pupils. Its subject was "Monkeys." He was educated first at a preparatory school at Brighton, and from 1877 to 1880 at Tonbridge School. Thence he had hoped to proceed to Cambridge; but a severe attack of enteric fever compelled him to take a year's rest, and thus prevented him from competing for an entrance scholarship at that University. He matriculated instead in the University of London, and entered St. Bartholomew's Hospital in 1882, sharing the intention of one of his father's pupils of becoming an Army doctor. This idea, however, he soon relinquished; but, like his desire to go to Cambridge, it was to be realised later in life.[2]

When he took his degree of Bachelor of Medicine in 1886 he was accounted the youngest Bachelor ever known at his hospital. Two years later he graduated as Doctor of Medicine, and he spent these two and the two following years in resident appointments at Chichester (1888) and at St. Bartholomew's (1889) hospitals, in a brief period of private medical practice (1890), and in travelling as ship's surgeon to America and Japan (1887), the first of numerous subsequent voyages.

In 1892 he spent the spring and early summer at Jena, attending the lectures of Eucken, Ziehen, Binswanger, and others. In a diary kept by him during this visit to Germany the following sentence occurs: "I have during the last few weeks come to the conclusion that I should go in for insanity when I return to England and work as much as possible at psychology." Accordingly, in the same year he became clinical assistant at the Bethlem Royal Hospital, and in 1893 he assisted G. H. Savage in his lectures on mental

[1] From the presidential address delivered to Section J (Psychology) of the British Association at Hull on Sept. 11.

[2] For many of the above details of Rivers's early life and antecedents I am indebted to his sister, Miss K. E. Rivers.

diseases at Guy's Hospital, laying special stress on their psychological aspect. Meanwhile, at Cambridge, Michael Foster was seeking some one who would give instruction there in the physiology of the sense organs, McKendrick having, as examiner in physiology, recently complained of the inadequate training of the Cambridge students in this branch of the subject. Foster's choice fell on Rivers, and in 1893 he invited him to the University for this purpose. Rivers went to Germany for a short period of study under Professor Kräpelin, then of Heidelberg, whose brilliant analysis of the work curve and careful investigations into the effects of drugs on bodily and mental work had aroused his intense interest. At Cambridge he set himself to plan one of the earliest systematic practical courses in experimental psychology in the world, certainly the first in this country. In 1897 he was officially recognised by the University, being elected to the newly established lectureship in physiological and experimental psychology. But the welcome and encouragement he received from cognate branches of study at Cambridge could scarcely be called embarrassing. Even to-day practical work is not deemed essential for Cambridge honours candidates in elementary psychology; psychology is not admitted among the subjects of the Natural Sciences Tripos; and no provision is made for teaching the subject at Cambridge to medical students. Rivers first turned his attention principally to the study of colour vision and visual space perception. Between 1893 and 1901 he published experimental papers "On Binocular Colour-mixture" (Proc. Cambs. Philosoph. Soc., vol. viii., pp. 273-77), on "The Photometry of Coloured Papers" (*Jour. of Physiol.*, vol. xxii., pp. 137-45), and "On Erythropsia" (Trans. Ophthal. Soc., London, vol. xxi., pp. 296-305), and until 1908 he was immersed in the task of mastering the entire literature of past experimental work on vision, the outcome of which was published in 1900 as an article in the second volume of the important "Text-book of Physiology," edited by Sir Edward Sharpey Schafer. This exhaustive article of 123 pages on vision by Rivers is still regarded as the most accurate and careful account of the whole subject in the English language.

In 1896 Rivers published an important paper "On the Apparent Size of Objects" (*Mind*, N.S., vol. v., pp. 71-80), in which he described his investigations into the effects of atropin and eserin on the size of seen objects. He distinguished two kinds of micropsia which had hitherto been confused—micropsia at the fixation-point due to irradiation, and micropsia beyond the fixation-point, which is of special psychological importance. Rivers came to the interesting conclusion that the mere effort to carry out a movement of accommodation may produce the same micropsia as when that effort is actually followed by movement. In other words, an illusion of size may be dependent solely on central factors. His later work, in conjunction with Prof. Dawes Hicks, on "The Illusion of Compared Horizontal and Vertical Lines," which was published in 1908 (*Brit. Jour. of Psychol.*, vol. ii., pp. 241-60), led him to trace this illusion to origins still less motor in nature. Here horizontal and vertical lines were compared under tachistoscopic and under prolonged exposure. The amount of the illusion was found to be approximately the same for tachistoscopic as for prolonged exposure of the lines, but in the former the judgment was more definite and less hesitating—in other words, more naïve, more purely sensory, more "physiological"—than in prolonged exposure. Although this result is not inconsistent with the view that visual space perception depends *for its genesis* on eye movement, it compels us to admit that visual space perception, *once acquired*, can occur in the absence of eye movement; or, in more general language, that changes in consciousness, originally arising in connexion with muscular activity, may occur later in the absence of that activity. The provision of experimental evidence in favour of so fundamental and wide-reaching a view is obviously of the greatest importance.

In 1898, in which year he was given the degree of Hon. M.A. at Cambridge, Rivers took a fresh path in his varied career by accepting Dr. A. C. Haddon's invitation to join the Cambridge Anthropological Expedition to the Torres Straits. This was the first expedition in which systematic work was carried out in the ethnological application of the methods and apparatus of experimental psychology. His former pupils, Prof. W. McDougall and I, assisted Rivers in this new field. Rivers interested himself especially in investigating the vision of the natives—their visual acuity, their colour vision, their colour nomenclature, and their susceptibility to certain visual geometric illusions. He continued to carry out psychological work of the same comparative ethnological character after his return from the Torres Straits in Scotland (where he and I sought comparative data), during a visit to Egypt in the winter of 1900, and from 1901–2 in his expedition to the Todas of Southern India. His psychological investigations among the Torres Straits islanders, Egyptians and Todas (Reports of the Cambridge Anthrop. Exped. to Torres Straits, vol. ii., Pt. I., pp. 1-132; *Jour. of Anthrop. Inst.*, vol. xxxi., pp. 229-47; *Brit. Jour. of Psychol.*, vol. i., pp. 321-96) will ever stand as models of precise, methodical observations in the field of ethnological psychology. Nowhere does he disclose more clearly the admirably scientific bent of his mind—his insistence on scientific procedure, his delight in scientific analysis, and his facility in adapting scientific methods to novel experimental conditions. He reached the conclusion that no substantial difference exists between the visual acuity of civilised and uncivilised peoples, and that the latter show a very definite diminution in sensibility to blue, which, as he suggested, is perhaps attributable to the higher macular pigmentation among coloured peoples. He observed a generally defective nomenclature for blue, green, and brown among primitive peoples, both white and coloured, and large differences in the frequency of colour-blindness among the different uncivilised peoples whom he examined. In his work on visual illusions he found that the vertical-horizontal-line illusion was more marked, while the Müller-Lyer illusion was less marked, among uncivilised than among civilised communities; and he concluded that the former illusion was therefore dependent rather on physiological, the latter rather on psychological factors, the former being counteracted, the latter being favoured, by previous experience, *e.g.* of drawing lines or of apprehending complex figures as wholes.

In 1903, the year after his return from the Todas, and the year of his election to a Fellowship at St. John's College, Rivers began an investigation, continued for five years, with Dr. Henry Head, in which the latter, certain sensory nerves of whose arm had been experimentally divided, acted as subject, and Rivers acted as experimenter, applying various stimuli to the arm and recording the phenomena of returning cutaneous sensibility. The exact interpretation of this "Human Experiment in Nerve Division," published at length in 1908 (*Brain*, vol. xxxi., pp. 323-450), has been disputed by subsequent workers, whose divergent results, however, are at least partly due to their employment of different methods of procedure. Head's experiment has never been identically repeated, and until this has been done we are probably safe in trusting to the results reached by the imaginative genius and the cautious critical insight of this rare combination of investigators.

While working upon Head's arm, Rivers's indomitable activity led him to simultaneous occupation in other fields. In 1904 he assisted Prof. James Ward to found and to edit the *British Journal of Psychology*, and in that year he also received an invitation to deliver the Croonian Lectures in 1906 at the Royal College of Physicians, of which in 1899 he had been elected a Fellow. The study of drug effects had long interested him. So, reverting to the work he had done under Kräpelin many years previously, he chose as his subject for the Croonian Lectures, "The Influence of Alcohol and other Drugs on Fatigue" (Arnold, 1908). But although he utilised Kräpelin's ergograph and many of Kräpelin's methods, Rivers's *flair* for discovering previous "faulty methods of investigation" and his devotion to scientific methods and accuracy could not fail to advance the subject. Of no one may it be more truly said than of him,—*nihil tetigit quod non ornavit.* He felt instinctively that many of the supposed effects of alcohol were really due to the suggestion, interest, excitement or sensory stimulation accompanying the taking of the drug. Accordingly he disguised the drug, and prepared a control mixture which was indistinguishable from it. On certain days the drug mixture was taken, on other days the control mixture was taken, the subject never knowing which he was drinking. He found that the sudden cessation of all tea and coffee necessary for the study of the effects of caffeine induced a loss of energy, and that other mental disturbance might occur through giving up all forms of alcoholic drink. Therefore most of his experiments were carried out more than twelve months after the taking of these drinks had been discontinued. Instead of recording a single ergogram Rivers took several sets of ergograms each day, each set consisting usually of six ergograms taken at intervals of two minutes, and separated from the next set by an interval of thirty or sixty minutes. He arranged that the drug mixture or the control mixture should be taken after obtaining the first set of ergograms, which served as a standard wherewith subsequent sets on the same day might be compared. He worked with Mr. Webber on alcohol and caffeine, and was followed by the similar work of Dr. P. C. V. Jones in 1908 on strychnine, and of Dr. J. G. Slade in 1909 on Liebig extract.

With these vast improvements in method Rivers failed to confirm the conclusions of nearly all earlier investigators on the effects of from 5 to 20 c.c. of absolute alcohol on muscular work. His results with these doses, alike for muscular and mental work, were mainly negative, and indeed with larger doses (40 c.c.) were variable and inconclusive; although an equivalent quantity of whisky gave an immediate increase of muscular work—a result which strongly suggests the influence of sensory stimulation rather than the direct effect of the drug on the central nervous system or on the muscular tissues. Rivers concluded that alcohol may in some conditions favourably act on muscular work by increasing pleasurable emotion and by dulling sensations of fatigue, but that probably its most important effect is to depress higher control, thus tending to increase muscular and to diminish mental efficiency.

From the concluding passages of these Croonian Lectures the following sentences may be aptly cited: "The branch of psychology in which I am chiefly interested is that to which the name of individual psychology is usually given. It is that branch of psychology which deals with the differences in the mental constitutions of different peoples, and by an extension of the term to the differences which characterise the members of different races. . . . These experiments leave little doubt that variations in the actions of drugs on different persons may have their basis in deep-seated physiological variations, and I believe that the study of these variations of susceptibility may do more than perhaps any other line of work to enable us to understand the nature of temperament and the relation between the mental and physical characters which form its two aspects." Throughout his life Rivers was steadfast to this biological standpoint, correlating the psychological with the physiological, and hoping to discover different mental levels corresponding to different neural levels.

Now we approach the last phase of Rivers's psychological work, the outcome of his war experiences. In 1907 he had given up his University teaching in experimental psychology; for six years before the war he had published nothing of psychological or physiological interest. This was a period in which Rivers devoted himself wholly to the ethnology and sociology of primitive peoples. The outbreak of war found him for the second time visiting Melanesia for ethnological field work. Failing at first to get war work on his return to England, Rivers set himself to prepare the Fitzpatrick Lectures on "Medicine, Magic and Religion," which he had been invited to deliver to the Royal College of Physicians of London in 1915 and 1916. In 1915 his psychological and ethnological researches were recognised by the award to him of a Royal Medal by the Royal Society, of which he had been elected a Fellow in 1908. In July 1915 he went as medical officer to the Maghull War Hospital, near Liverpool, and in 1916 to the Craiglockhart War Hospital, Edinburgh, receiving a commission in the R.A.M.C. In these hospitals he began the work on the psychoneuroses that led him to his studies of the unconscious and of dreams, which resulted in his well-known book, "Instinct and the Unconscious," and in a practically completed volume on "Conflict and Dream," which is to be published posthumously. From 1917 he acted as consulting psychologist to the

Royal Air Force, being attached to the Central Hospital at Hampstead.

This period marks not merely a new phase in Rivers's work, but is also characterised by a distinct change in his personality and writings. In entering the Army and in investigating the psychoneuroses he was fulfilling the desires of his youth. Whether through the realisation of such long-discarded or suppressed wishes, or through other causes, *e.g.* the gratified desire of an opportunity for more sympathetic insight into the mental life of his fellows, he became another and a far happier man. Diffidence gave place to confidence, hesitation to certainty, reticence to outspokenness, a somewhat laboured literary style to one remarkable for its ease and charm. More than forty publications can be traced to these years, between 1916 and the date of his death. It was a period in which his genius was released from its former shackles, in which intuition was less controlled by intellectual doubt, in which inspiration brought with it the usual accompaniment of emotional conviction—even an occasional impatience with those who failed to accept his point of view. But his honest, generous character remained unchanged to the last. Ever willing to devote himself unsparingly to a cause he believed right, or to give of his best to help a fellow-being in mental distress, he worked with an indomitable self-denying energy, won the gratitude and affection of numberless nerve-shattered soldier-patients, whom he treated with unsurpassed judgment and success, and attracted all kinds of people to this new aspect of psychology. Painters, poets, authors, artisans, all came to recognise the value of his work, to seek, to win, and to appreciate his sympathy and his friendship. It was characteristic of his thoroughness that while attached to the Royal Air Force he took numerous flights, looping the loop and performing other trying evolutions in the air, so that he might gain adequate experience of flying and be able to treat his patients and to test candidates satisfactorily. He had the courage to defend much of Freud's new teaching at a time when it was carelessly condemned *in toto* by those in authority who were too ignorant or too incompetent to form any just opinion of its undoubted merits and undoubted defects. He was prepared to admit the importance of the conflict of social factors with the sexual instincts in certain psychoneuroses of civil life, but in the psychoneuroses of warfare and of occupations like mining he believed that the conflicting instincts were not sexual, but were the danger instincts, related to the instinct of self-preservation.

Thus in the best sense of the term Rivers became a man of the world and no longer a man of the laboratory and of the study. He found time to serve on the Medical Research Council's Air Medical Investigation Committee, on its Mental Disorders Committee, on its Miners' Nystagmus Committee, and on the Psychological Committee of its Industrial Fatigue Research Board. He served on a committee, of ecclesiastical complexion, appointed to inquire into the new psychotherapy, and he had many close friends among the missionaries, to whom he gave and from whom he received assistance in the social and ethnological side of their work.

In 1919, in which year he received honorary degrees from the Universities of St. Andrews and Manchester, he returned to Cambridge as Prælector in Natural Sciences at St. John's College, and began immediately to exercise a wonderful influence over the younger members of the University by his fascinating lectures, his "Sunday evenings," and above all by his ever-ready interest and sympathy. As he himself wrote, after the war work "which brought me into contact with the real problems of life . . . I felt that it was impossible for me to return to my life of detachment." And when a few months before his death he was invited by the Labour Party to a still more public sphere of work, namely, to become a Parliamentary candidate representing the University of London, once again he gave himself unsparingly. He wrote at the time: "To one whose life has been passed in scientific research and education the prospect of entering practical politics can be no light matter. But the times are so ominous, the outlook both for our own country and the world so black, that if others think I can be of service in political life I cannot refuse." On several occasions subsequently he addressed interested London audiences, consisting largely of his supporters, on the relations between psychology and politics. It was one of these very lectures—on the herd instinct—at which it happened that I took the chair, which was to have formed the basis of his Presidential Address to you here to-day.

Rivers's views on the so-called herd instinct were the natural outcome of those which he had put forward during the preceding five years and collected together in his "Instinct and the Unconscious." His aim in writing this book was, as he says, "to provide a biological theory for the psychoneuroses," to view the psychological from the physiological standpoint. He maintained that an exact correspondence holds between the inhibition of the physiologist and the repression of the psychologist. He regarded mental disorders as mainly dependent on the coming to the surface of older activities which had been previously controlled or suppressed by the later products of evolution. Here Rivers went beyond adopting Hughlings Jackson's celebrated explanation of the phenomena of nervous diseases as arising largely from the release of lower-level activities from higher-level controls. He further supposed that these lower-level activities represent earlier racial activities held more or less in abeyance by activities later acquired. This conception he derived from his work with Henry Head on cutaneous sensibility. Rivers could see but "two chief possibilities" of interpreting the phenomena disclosed in the study of Head's arm. Either epicritic sensibility is protopathic sensibility in greater perfection, or else protopathic sensibility and epicritic sensibility represent two distinct stages in the development of the nervous system. Failing to see any other explanation, he adopted the second of these alternatives. He supposed that at some period of evolution, when epicritic sensibility, with its generally surface distribution, its high degree of discrimination, and its power of accurate localisation, made its appearance, the previously existing protopathic sensibility, with its punctate distribution, its "all-or-nothing" character, and its broad radiating localisation, became in part inhibited or "suppressed," in part blended or "fused" with the newly acquired sensibility so as to form a useful product. He supposed that the suppressed portion

persisted in a condition of unconscious existence, and he emphasised the biological importance of suppression. He considered at first that the protopathic sensibility "has all the characters we associate with instinct," whereas the later epicritic sensibility has the characters of intelligence or reason. So he came to hold that instinct "led the animal kingdom a certain distance in the line of progress," whereupon "a new development began on different lines," "starting a new path, developing a new mechanism which utilised such portions of the old as suited its purpose."

Evolutio per saltus was thus the keynote of Rivers's views on mental development. Just as the experience of the caterpillar or tadpole is for the most part suppressed in the experience of the butterfly or frog, so instinctive reactions tend to be suppressed in intelligent experience whenever the immediate and unmodifiable nature of one becomes incompatible with the diametrically opposite characters of the other. Just as parts of the protopathic fuse with the later acquired epicritic sensibility, so parts of our early experience, of which other parts are suppressed, fuse with later experience in affecting adult character. "Experience," he explained, "becomes unconscious because instinct and intelligence run on different lines and are in many respects incompatible with one another."

From his point of view Rivers was naturally led, wherever possible, to interpret abnormal mental conditions in terms of regression to more primitive, hitherto suppressed activities. He held that the hysterias are essentially "substitution neuroses," connected with and modified by the gregarious instincts, and are primarily due to a regression to the primitive instinctive danger reaction of immobility, greatly modified by suggestion. So, too, he held that the anxiety neuroses, which are for him essentially "repression neuroses," also show regression, though less complete, in the strength and frequency of emotional reaction, in the failure during states of phantasy to appreciate reality, in the reversion to the nightmares, and especially the terrifying animal dreams, characteristic of childhood, in the occurrence of compulsory acts, in the desire for solitude, etc. He criticised Freud's conception of the censorship, substituting in place of that anthropomorphically-coloured sociological parallel the physiological and non-teleological conception of regression.

We are now in a position to examine Rivers's treatment of the gregarious behaviour of animal and human life, on which he was still engaged at the time of his death. In the gregarious instinct he recognised a cognitive aspect which he termed "intuition," an affective aspect which he termed "sympathy," and a motor aspect which he termed "mimesis." He used "mimesis" for the process of imitation so far as it was unwitting; "sympathy" he regarded as always unwitting. "Intuition" he defined as the process whereby one person is unwittingly influenced by another's cognitive activity. But I feel sure that the term "unwittingly" is not to be considered here as equivalent to "telepathically." All that Rivers meant was that the person is influenced by certain stimuli without appreciating their nature and meaning. He preferred to employ the term "suggestion" as covering all the processes by which one mind acts on or is acted on by another unwittingly. He supposed that in the course of mental evolution epicritic characters displaced the early protopathic characters of instinctive behaviour owing to the incidence of gregarious life, especially among insects, and owing to the appearance and development of intelligence, especially in man. The suggestion inherent in gregarious behaviour implies some graduation of mental and bodily activity—an instinctive and unwitting discrimination distinct from the witting discrimination of intelligence.

Were he here to-day Rivers would have carried this conception of the evolution of gregarious life still further by distinguishing between the more lowly leaderless herd and the herd which has acquired a definite leader. He would have traced the development of the new affect of submission and of the new behaviour of obedience to the leader, and he would doubtless have accredited the leader with the higher affects of superiority and felt prestige, with the higher cognition that comes of intuitive foresight, and with the higher behaviour of intuitive adaptation, initiative, and command. I expect, too, that he would have sketched the development of still later forms of social activity, complicated by the interaction and combination of intellectual and instinctive processes—the witting deliberations and decisions on the part of the leader, and the intellectual understanding of the reasons for their confidence in him and for their appropriate behaviour on the part of those who are led.

But it would be idle further to speculate on the ideas of which we have been robbed by Rivers's untimely death. Let us rather console ourselves with the vast amount of valuable and suggestive material which he has left behind and with the stimulating memories of one who, despite the fact that his health was never robust, devoted himself unsparingly to scientific work and to the claims of any deserving human beings or of any deserving humane cause that were made upon him. There are, no doubt, some who believe that Rivers's earlier experimental psychological work—on vision, on the effects of drugs, and on cutaneous sensibility—is likely to be more lasting than his later speculations on the nature of instinct, the unconscious, dreams, and the psychoneuroses. No one can doubt the scientific permanence of his investigations in the laboratory or in the field; they are a standing monument of thoroughness and accuracy combined with criticism and genius. But even those who hesitate to suppose that at some definite period in mental evolution intelligence suddenly made its appearance and was grafted on to instinct, or that epicritic sensibility was suddenly added to a mental life which had before enjoyed only protopathic sensibility—even those who may not see eye to eye with Rivers on these and other fundamental views on which much of his later work rested, will be foremost in recognising the extraordinary stimulating, suggestive, and fruitful character of all that he poured forth with such astounding speed and profusion during the closing years of his life. Above all, we mourn a teacher who was not merely a man of science devoted to abstract problems, but who realised the value of and took a keen delight in applying the knowledge gained in his special subject to more real and living problems of a more concrete, practical, everyday character. Rivers's careful methods of investigating

cutaneous sensibility and the *rationale* of his successful treatment of the psychoneuroses were directly due to his psychological training. So, too, his epoch-making discoveries and his views in the field of anthropology on the spread and conflict of cultures were largely due to the application of that training. Shortly before his death he was developing, as a committee member of the Industrial Fatigue Research Board, an intense interest in that youngest application of psychology, namely, to the improvement of human conditions in industrial and commercial work by the methods of experimental psychology applied to fatigue study, motion study, and vocational selection.

Unhappily, men of such wide sympathies and understanding as Rivers, combined with a devotion to scientific work, are rare. He himself recognised that "specialisation has . . . in recent years reached such a pitch that it has become a serious evil. There is even a tendency," he rightly said, "to regard with suspicion one who betrays the possession of knowledge or attainments outside a narrow circle of interests" (*Brit. Jour. of Psychol.*, vol. x., p. 184). Let his life, his wisdom, his wide interests, sympathies and attainments, and the generosity and honesty of his character, be an example to us in the common object of our meeting this week—the advancement of science.

Obituary.

PROF. F. D. BROWN.

WE regret to announce the death, on August 2, at Remuera, New Zealand, of emeritus professor Frederick Douglas Brown, at the age of seventy years. Prof. Brown began the study of chemistry in 1870, under Dr. Matthiessen, at St. Bartholomew's Hospital. On the death of Dr. Matthiessen, he continued his studies at the Royal College of Science, South Kensington and afterwards in Leipzig. On his return to England about 1876, he began research work at the London Institution with Prof. Armstrong, whom he had known at St. Bartholomew's. He then spent some time in Prof. Guthrie's laboratory and afterwards in the University Laboratory, Oxford. During this period, he was concerned in the teaching of chemistry at Cheltenham and Clifton Colleges and he also supervised the construction of the chemical laboratories in University College, Nottingham.

In 1883, Brown was appointed professor of chemistry and physics in Auckland University College, a post he held until 1914, when he came to England; but he was so upset by the conditions of the war, especially the bombing, that he gave up his intention of settling here and, in 1918, returned to the quiet of New Zealand. He did the greatest possible service to the cause of scientific education in New Zealand, where he was generally held in high esteem.

A man of original and independent, aristocratic mind but entirely unobtrusive though charming manner, firm and clear in his convictions and with a specially developed sense of accuracy and thoroughness, Brown's scientific work was of a classic character, though through force of circumstances it could not be large in amount: however, he not only made the best of the material that was at his disposal in Auckland but was also successful in inspiring those who studied under him with his own high conceptions of scientific duty. The work by which he is best known probably is that relating to fractional distillation, a subject on which he was an authority in early days; he also paid much attention to the cyanide process of extracting gold.

PROF. F. T. TROUTON, F.R.S.

AT Trinity College, Dublin, in the 'eighties of last century, there assembled under Prof. FitzGerald a small band of enthusiastic physicists of great ability and originality, brought together by a common admiration and affection for their chief. Names which will always be connected with this brilliant school of physics are Joly, Preston, and Trouton. FitzGerald himself did not live to be fifty, Preston died in his fortieth year, and now, to the great grief of all those who ever knew him, Trouton has left us at the age of fifty-eight, after having been kept by illness for the past ten years from the researches he loved.

Trouton was born in Dublin in November 1863, the son of a family well known in that city. As a student at Trinity College he gave early evidence of that versatility and quickness of grasp which characterised his scientific career. He studied both engineering and the physical sciences, and before graduating had already on one hand taken a leading part in surveying for a railway, and on the other enunciated that connexion between latent heat and molecular weight which is known as Trouton's Law.[1] He closed a brilliant undergraduate career by taking degrees in engineering and science at the same time, being awarded the coveted Large Gold Medal, rarely bestowed for science. He at once became assistant to the professor of physics at Trinity College, and until FitzGerald's death in 1901 he remained the cherished colleague and intimate friend of that great man. They carried out in collaboration many experiments, including an important series confirming, to a high degree of accuracy, Ohm's law for electrolytes. Trouton never spoke of FitzGerald without emotion characteristic of his generous nature.

The Dublin school was immediately struck with the importance of Hertz's experiments on electromagnetic waves, which were published in 1887 and 1888, and Trouton was one of the first to repeat them and to carry out original work on the subject. He settled the long-disputed question as to the relation between the direction of the vibration in the wave-front of an electromagnetic (light) wave and the plane of polarisation, by showing that the electric vector is normal to, and the magnetic vector in, the plane of polarisation. He demonstrated many analogies with optical experiments by suitably increasing the size of the apparatus to correspond to the great wave-length of the Hertzian waves—thus a wall built of bricks of paraffin wax was used to replace the soap film of ordinary light experiments. Trouton's work did much to establish the common electromagnetic nature of ordinary light and of Hertzian waves.

[1] If M be the molecular weight, L the latent heat, T the absolute temperature, then ML/T is constant.

FitzGerald was deeply interested in the question of the possibility of detecting the earth's motion through the æther, and Trouton eagerly took up a suggestion to investigate the mechanical effect of charging a condenser moving in the plane of its plates through the æther. The experiment, which is well known to all students of relativity, gave a negative result. It was in 1902, just after this research, that Trouton was appointed to the Quain professorship of physics at University College, London. He had at the time been for some years a Fellow of the Royal Society. His first work here was to repeat, with Noble, the condenser experiment in an improved form. Later he devised another experiment, designed to detect the FitzGerald shrinkage, which consisted in comparing the electrical resistance of a wire when moving in and across the æther stream. This was carried out in collaboration with Mr. (now Prof.) A. O. Rankine, and led to a negative result. The results of these experiments are in accord with the theory of relativity, for which they offer important evidence.

Trouton carried out researches in a variety of directions, including some on the viscosity of solids, and others on the condensation of water vapour on different surfaces, the latter of which led to the discovery of an interesting analogy to the James Thomson portion of an isothermal. His last work was on the adsorption of dye-stuffs on sand at various concentrations, and gave results of an intriguing nature which cannot be described here. It was while engaged on these investigations in 1912 that Trouton was attacked by a severe illness. He recovered from a prolonged prostration sufficiently for it to be hoped that he would be able to attend the meeting of the British Association in Australia in 1914, and he was elected president of Section A for that meeting. He prepared his presidential address, but was unable to travel, as an early operation was advised. It was held to be partly successful, but he never walked again. When he resigned his professorship at University College he received the title of emeritus professor.

The investigation of newly discovered or of neglected phenomena had a great fascination for Trouton; he was always breaking fresh ground, and had little inclination for working over subjects on which many investigations had been carried out—" pouring water on a drowned rat," as he characteristically expressed it. In daily life he was a man of great charm and sincerity; his wit, his buoyancy, and his whimsical and incisive phrases were a constant delight. He never lost an opportunity of helping a student or colleague, and his kindliness was evident in all his actions, a kindliness which had its roots in strength, and not weakness, of character. When in the prime of life he was struck down by a cruel and lingering illness he carried his cheerfulness to his couch, and would receive visitors with something like the old twinkle in his eye. Fate did not spare him; he lost two hopeful and beloved sons in the war, and saw all hope of recovery slowly pass from him. He died peacefully at his house at Downe on September 21, and, although his death was not unexpected, it brought to his friends a distress no less poignant for that.

E. N. da C. A.

We regret to see announcements of the following deaths:—Prof. Arthur Mayer, formerly director of the Botanic Garden at Marburg, at the age of seventy-two years; Dr. William Kellner, formerly chemist to the War Department, aged eighty-two; on September 25, Prof. J. P. Kuenen, of the University of Leyden, aged fifty-five; on September 27, Mr. C. Michie Smith, late director of the Kodaikanal and Madras Observatories; and on September 28, Major-General James Waterhouse, from 1866 to 1897 Assistant Surveyor-General in charge of photographic operations in the Surveyor-General's Office, Calcutta, at the age of eighty years.

Current Topics and Events.

The hundreth anniversary of the birth of Mendel was celebrated in Brünn on September 23 last. The Government of Czecho-Slovakia placed generous funds at the disposal of a local committee, which arranged the centenary celebrations with the liberality and efficiency that we have learnt to expect from the new Czecho-Slovakian state. Credit is especially due to the committee for having made the centenary an occasion for bringing together, for the first time since the war, geneticists of all lands, the visitors comprising representatives of America, Austria, Denmark, England, Finland, Germany, Holland, India, Japan, Jugoslavia, Norway, Poland, Sweden, and Switzerland. The official proceedings opened with a visit to the monastery in which Mendel had lived, and to the adjoining garden in which he made his experiments. Wreaths were laid before the monument of Mendel which was erected in 1910, and speeches were made by the chairman of the local Naturwissenschaftlicher Verein, by the official representative of the Government, by the Burgomeister, by Prof. Erwin Baur (Berlin), Prof. Chodat (Geneva), Prof. Němec (Prague), Mr. S. Pease (Cambridge), and Prof. Iltis (Brünn). At the luncheon which followed, the principal speaker was Prof. Wettstein (Vienna), who emphasised particularly the international significance of the event. Prof. C. B. Davenport (Washington) replied, and the official proceedings terminated with a speech by Prof. Richard Hertwig (Munich). In the evening, a special performance was given at the opera, to which the guests were invited: it was the first occasion in Brünn on which the works of Czech and German composers had appeared on the same programme, a matter locally of much comment and great importance. The next day an expedition to recently discovered and very remarkable caves in the Moravian Karst was arranged. It is to be hoped that the success of this gathering will encourage others to organise congresses that are international and not merely inter-allied, in order that the friendships and intercourse which the war destroyed may be once more built up.

A kindly function was fulfilled at the London School of Tropical Medicine on Monday evening of last week, September 25, before a company of friends of the School and the family, when the first mint of the new medal instituted in memory of Sir Patrick Manson was presented to his widow. Major-General Sir William Leishman, who made the presentation, explained that the medal was the sub-issue of a project by friends of Sir Patrick Manson to present to the School a portrait of its illustrious originator. As the result of an appeal for this purpose, subscriptions in excess of the actual requirements quickly came in from many parts of the world, accompanied by numerous very cordial tributes of approval. The portrait had been presented, and when all expenses had been met there still remained a balance which the committee of subscribers thought would find its most happily inspired application in a medal commemorative of Sir Patrick Manson's unique position in the history of tropical medicine. In a graceful speech Sir William Leishman alluded to the many ways whereby, outside the laboratory, quite as effectively as within it, a wife can further her husband's work, and said that it was with a full appreciation of the circumstances from this point of view, and not as a mere compliment, that the committee desired to offer the first-minted medal to Lady Manson.

M. Le Trocquer, Minister of Public Works, was present at tests on September 26, in connexion with the utilisation of tidal power at Aberwrach, near Brest. The scheme is to comprise a barrage 150 metres in length, which will permit of the storage in a tidal basin of from one to four million cubic metres of water, depending on the tidal range. Four turbines are to be installed, working both on the ebb and flow of the tide and capable of delivering 750-1200 h.p. These are coupled to alternators delivering current at 1500 volts. This station is to work in conjunction with a water-power station developing power from river-flow, and the latter is to be used to regularise the intermittent output from the tidal-power scheme. Should the results of this investigation prove satisfactory it is intended to develop a much larger scheme on the Rance, and, according to the *Times* of September 28, the minister expressed the opinion that this would enable electrical energy to be supplied to the whole of Western France.

We learn from the *Chemical Age* that the chairman of the Allied Chemical and Dye Corporation of New York has offered, through the American Chemical Society, an annual prize of 25,000 dollars "to reward the chemist, residing in the United States, who in the opinion of a properly constituted jury has contributed most to the benefit of the science and of the world." In communicating the offer, the chairman of the Corporation writes: "Realising, as we do, the enormous influence which chemists working in all the fields of that science will have on the welfare of the world, we desire by this prize so to encourage the workers that even larger benefits should accrue than those which have already placed the world under such a debt of gratitude to the profession." Last week reference was made in our columns (p. 466) to numerous substantial gifts by industrial concerns in Germany to German universities to assist in the teaching of scientific subjects, particularly chemistry. Thus in both the United States and in Germany, commercial men and manufacturers are showing their appreciation of the value of what may be termed, research in pure science.

According to *Science*, the American Medical Association has agreed to co-operate with the directors of the Gorgas Memorial Institute of Tropical and Preventive Medicine in establishing the institute, and a committee of the Association has issued an appeal for subscriptions. The committee is agreed that the most suitable memorial to Major-General William C. Gorgas would be such an institute, and considers that no more appropriate place than Panama City, where General Gorgas's great work in stemming tropical diseases was done, could have been selected. The Government of Panama has given the Santo Tomas Hospital, and also the land on which it is proposed to build the laboratories and departments for research, to constitute the memorial institute; Dr. R. P. Strong has been appointed scientific director. It is also intended that a Gorgas School of Sanitation shall be established in Tuscaloosa, Alabama, for training public health workers and sanitary engineers especially for work in the Southern States of America. An endowment of some 1,300,000*l.* will be necessary to carry out in full the proposed memorial.

Prof. Santiago Ramón y Cajal has retired from the chair of histology and pathological anatomy in the University of Madrid. This distinguished man of science, who is a Foreign Member of the Royal Society, has been the recipient of numerous honours in Spain, including the Echegaray medal, presented to him in the Royal Academy of Sciences by the King of Spain. The Spanish Government has introduced a bill for the construction of a building for the Cajal Institute, constituted in 1920, which carries with it an appropriation of nearly 36,000*l.*, divided into four sums to be expended annually from 1922 to 1925 on the building designated as Cajal's Biological Institute; in addition, a grant of about 1700*l.* is to be provided for maintenance. The work of the institute will be directed by a board of trustees under the chairmanship of Cajal himself.

About a year ago the Chemical Society issued an appeal to its fellows to assist in the alleviation of distress among chemists and other scientific workers in Russia. Since then a sum of more than 210*l.* has been received, and about 170*l.* of it was devoted to the purchase of clothing, which has been distributed among men of science in Ekaterinburg, Moscow, and Petrograd. In addition, three cases containing clothing and books have been sent to the latter two cities. It is now known definitely that the packages have reached those for whom they were intended, so that the possibility of gifts going astray need no longer deter possible subscribers. There is every reason to fear that during the coming winter distress will be as acute as it was a year ago, and the Chemical

Society appeals to all British chemists to give assistance. Gifts of money, clothing, books, and recent chemical literature should be addressed to the Assistant Secretary, The Chemical Society, Burlington House, Piccadilly, W.1.

IN his presidential address delivered before the Royal Anthropological Institute (vol. lii. part i.) the late Dr. Rivers laid special stress on the difficulties which impede research by the excessive cost of printing and book production, and the rise in rent and taxes for accommodation used by scientific societies. He pointed out how closely all the branches of anthropological work—physical, sociological, archæological, psychological—are connected. Numerous societies, like the Royal Asiatic, African, and Japan societies, with the Hellenic and Roman societies and that specially devoted to folk-lore, should become more closely allied than is the case at present. The provision of a common building with adequate accommodation for a lecture room, library, and secretarial quarters would do much to reduce expenditure and promote efficiency. The leading society, the Royal Anthropological Institute, is most inadequately housed, while the Folk-lore Society has no headquarters of its own. It is quite time that an earnest effort was made to reorganise the work of these and similar societies. Individual jealousies and prejudices must be encountered, but the spirit of conciliation, reinforced by the difficulties of the present situation, should succeed in framing a scheme of co-operation.

IN accordance with arrangements followed for many years past there is to be a series of meetings, generally on alternate Mondays at 5 P.M., at the Meteorological Office, South Kensington, for the informal discussion of important contributions to meteorological literature, especially in foreign and Colonial journals. The meetings will commence on Monday, October 16, when, as customary at the first meeting, the discussion will be opened by Sir Napier Shaw. The subject is a paper by V. Bjerknes "On the dynamics of the circular vortex with application to the atmosphere and atmospheric vortex of wave motions."

THE third of the series of lectures, under the auspices of the Institute of Physics, on physics and the physicist in industry will be given by Mr. Clifford C. Paterson, who will take as his subject, "The Physicist in Electrical Engineering." The lecture will be delivered on Wednesday October 18 at 6 P.M. at the Institution of Electrical Engineers, Victoria Embankment, W.C.2.

ON the recommendation of the committee of management of *Science Abstracts*, the council of the Institution of Electrical Engineers has appointed Mr. W. R. Cooper to be editor of the publication in succession to the late Mr. L. H. Walter. Mr. Cooper was acting editor of *Science Abstracts* in the first year of its existence, 1898, and afterwards was editor from 1899 to 1901.

THE Home Secretary gives notice that summer time will cease this year at 3.0 A.M. (summer time) in the morning of Sunday, October 8, when clocks will be put back to 2 A.M. The shorter period of summer time prescribed by the Summer Time Act, 1922, does not operate this year.

Our Astronomical Column.

OCTOBER METEOR SHOWERS.—The month of October is usually one of the best periods for observing meteors. The moon will interfere this year in the early part of the month, but during the last half, observations may be satisfactorily made. The chief shower generally visible falls in the third week of the month, and is directed, from a radiant point at 91° +15° on the north-eastern borders of Orion. There is also a strong shower which supplies slow and often brilliant meteors at about the same time as the Orionids, but this radiant in the eastern region of Aries at 42° +21° appears to be visible for a long period, and is also seen in the months of November and December. The Taurids often form a conspicuous display towards the end of October, but they are generally more abundant in November than at any other time of the year. The latter shower yields meteors very similar to the Arietids, and fireballs are frequently intermingled with the smaller members of the stream. The chief radiant is at 64° +22°; it is difficult to define the date of maximum, but it usually occurs between November 20 and 23.

The meteoric activity of October is not confined to a few systems, for a very large number, certainly several hundreds, may be recognised. They are, however, for the most part feeble, like the majority of the systems which are distributed over the firmament.

PARALLAXES OF 22 CEPHEIDS. — Dr. Harlow Shapley's estimates of the distances of the globular clusters rest largely on the assumed absolute magnitudes of B stars and Cepheid variables. It is very desirable to have as many independent determinations as possible of the distances of the brighter Cepheids, in order to check their assumed absolute magnitudes. Dr. S. A. Mitchell has determined the trigonometrical parallaxes of 22 of them, and publishes the results in the *Observatory* for September. Perhaps the most doubtful point is the mean parallax of the comparison stars; they are of the 10th magnitude, assumed parallax 0″·005. The deduced absolute parallaxes for the Cepheids range from +0″·046 (ρ Cassiopeiae) to −0″·018 (41 Cygni). There are only 3 negative parallaxes. The mean parallax agrees very closely with the mean of the spectroscopic values; rejecting ρ Cassiopeiae, the mean difference, Mitchell *minus* spectroscopic, is only 0″·0003. It is concluded that the latter are very accurate.

NOVA T CORONAE (1866).—This Nova is exceptional in two ways. It is the only Nova that was a catalogued star before the outburst (BD +26° 2765), and it is much farther from the Galaxy than other Novae. Mr. K. Lundmark investigates its proper motion and parallax in Publ. Ast. Soc. Pacific, August 1922. The proper motion is given as 0″·012 annually, towards position angle 41°; from this the parallax is inferred to be 0″·0010, while the spectroscopic parallax is 0″·0014. Adopting 0″·0013, its present absolute magnitude is +0·2, while that at the outburst was −7·4, in good agreement with the maximum value for other Novae. The star is an M giant, and apparently is now in the same condition as before the outburst. If the above parallax is near the truth, the star is considerably more remote than Nova Persei (1901) or Nova Aquilae (1918).

Research Items.

The Statue of Sophocles in the Lateran Museum.—The chief glory of the Lateran Museum is the great statue usually supposed to be that of the poet Sophocles. This identification is disputed by Mr. Theodore Reinach (Journal of the Hellenic Society, vol. xlii. Part 1), who, after a full discussion of the evidence, identifies it with the famous statue of Solon of Salamis, dating about 391 B.C., the work of the artist Kephisodotus, whose son and pupil seems to have been Praxiteles. This new work by a great master thus stands out as the herald of a new dawn of art, the real link between the divine Phidias and the divine Praxiteles.

Excavations at the Site of Bethshean.—The town of Bethshean, afterwards, for some unexplained reason, known as Scythopolis, lay between the Little Hermon and Gilboa ranges, on a plain about three miles west of the Jordan. Permission to excavate the site by the University Museum, Philadelphia, having been granted by the Archæological Department of Palestine, the work was started in 1921 under the superintendence of Mr. C. S. Fisher. Fortunately no Mahomedan tombs or other buildings on the mound interfere with the work of excavation. The stratification shows a continuous occupation of the site from Arab, Byzantine, and Classical times down to the early Semitic period. The results of the excavations, so far as they have proceeded, are described in the March issue of the *Museum Journal*. The most important discovery made is that of a large basalt stele with an Egyptian inscription of Sety I. (1313–1292 B.C.). When the lowest stratum is reached it is hoped that much light will be thrown on early Semitic life and religion.

Bantu Throwing-stones and Brass.—In the Report of the South African Museum for 1921, Dr. Péringuey discusses some large rounded stones, perforated in the manner of the Bush *Kwe*, and weighing about 18 lb. He does not think that they could have been used to weight digging-sticks or as rolling mill-stones. With them were some stones, also perforated, but rather flat, with a sharp edge. These, it is said, were carried on a stick by the Bantu, and used for throwing at the legs of bucks. This explains the use of some heavy brass rings found in Swaziland, and the question arises whether the brass was made in that country or was imported. The Chief Regent of Swaziland says that the former was the case, and adds: "The process of separating was by melting the minerals and certain chemicals known to our ancient blacksmiths and founders. In the making of brass and other metals, copper, lead, and zinc were used for the manufacture of bangles, etc., which were worn only by Royalties. The bangle in this form is known as Itusi; it is the form in which brass is kept, instead of making it into bars as the Europeans do." Specimens in the museum show that the Bantu had also a bronze industry, but the rarity of such objects is rather remarkable, and Dr. Péringuey suggests as the reason the very early supersession of bronze by iron in South Africa.

Physical Nature of Verse.—A recent number of the *Wiener Medizinische Wochenschrift* reports a lecture at the University of Vienna by Prof. E. W. Scripture, of London and Hamburg, on recent researches in experimental phonetics. Speech is registered by physical means on a recording drum, and the resulting curves are analysed and measured under a microscope. One of the latest problems is that of the physical nature of verse. Verse is shown to be a continuous vocal gesture. There are no syllables, no feet, no measures, no possibility of such notions as iambus or trochee. The entire system of metre as taught in modern prosody is held to be a fantastic construction that has not the slightest relation to verse as actually spoken. Any attempt to fit it to verse or fit verse to it results in such monstrosities as some of the present corrections to the text of Shakespeare, with apologies for the bad verse he is supposed to have written. Verse, from a physical point of view, is shown to be a flow of speech energy with regularly recurring regions of greater density. The total of this energy can be treated as if condensed at certain points—centroids or centres of gravity. These centroids recur at regular intervals and give the effect of beats. This regular recurrence of centroids constitutes the whole of the system of verse. Another topic presented was the recent work on registering speech in nervous diseases. Three diseases—epilepsy, disseminated sclerosis, and general paralysis—show specific peculiarities in the records. A diagnosis thus becomes an automatic thing; the speech is registered, the curves are analysed and measured, and the result appears of itself.

The Site and Growth of London.—The relation of topography and underlying structure to the growth of London are traced in some detail by Mr. C. E. M. Bromehead in a paper in the *Geographical Journal* for August. After describing the extent of alluvial and river gravels and the course of the Thames tributaries in the area now covered by London, Mr. Bromehead points out that the narrowness of the river and the approach by gravel banks from either side marked the present site of London Bridge as the lowest ford. Around this, especially on the better situated northern bank, the original London grew. The essentials of the site, in addition to the ford, were twin hills capped by water-bearing gravels separated by the valley of the Wall Brook, bounded on the west by the Fleet and on the east by the low ground of the Thames marshes. To the north was the forest area of the London clay, but the river gravels were comparatively bare. The early Roman camp, which was the earliest historic London, was on the east hill; on the west hill the brick earth was worked until the city grew over it. Mr. Bromehead traces the growth of London through Saxon times and up to the Great Fire in 1666. After that event London rapidly expanded. The limit of the gravels for a long time set a limit to building operations. Wells sunk through the gravel, seldom more than 25 ft. in thickness, were sure to tap water, but it was not realised till recent times that better supplies could be obtained beneath the clay at depths of 150 ft. and more. It was for this reason that the areas of bare London clay remained unoccupied until the advent of steam pumping and iron water mains. Once these difficulties of water supply were overcome, the clay areas were rapidly built over and outlying hamlets became linked up with London.

Median Prolification of Flowers of Hemerocallis.—We learn from Dr. J. C. Costerus, of Hilversum, Holland, that he has observed numerous central floral prolifications in *Hemerocallis fulva* in gardens at Hilversum, in the botanic gardens at Amsterdam and Utrecht, and also at Twickenham in this country, during the past summer. Apparently the prolification resembled closely a "doubled" flower. Median prolification of flowers of Hemerocallis, although apparently rare, has been noted on

several occasions and is referred to in "Vegetable Teratology," by the late Dr. Maxwell T. Masters. While it is difficult to suggest a reason for the phenomenon with any degree of certainty, it is probable that the condition may have been more prevalent than usual this year owing to the prolonged drought of 1921 and the early months of 1922, placing a check upon normal development, followed by a rush of vigorous growth brought about by the wet summer months. A check to growth followed by a sudden change to first-rate growing conditions often brings about fasciation, and the median prolification of flowers of Hemerocallis may be regarded in a rather similar light to fasciation.

LIFE-HISTORY OF THE NEUROPTEROUS INSECT ITHONE.—In the Bulletin of Entomological Research, vol. xiii. pt. 2, August 1922, Dr. R. J. Tillyard gives a very detailed account of the biology of *Ithone fusca*, an Australian moth-lacewing. It appears that the complete life-history occupies two years, and the eggs are laid in soft or sandy ground, each being rolled separately in the sand, which adheres to its sticky surface, forming a protective covering. The larvæ are very different from those of other Neuroptera Plannipennia, being curved and more or less scarabæiform in their general features. There appear to be at least five instars instead of the usual three or four present in other members of the suborder. The cocoon is spun from the anal end of the body, and the pupa is armed with large jaws for cutting a way out for the emergence of the imago. The larval food appears to be mainly scarabæid grubs, and Dr. Tillyard is so impressed with the value of Ithone in reducing the numbers of these organisms, that he has decided to test its capabilities as an aid to agriculture in New Zealand. Some 7000 fertile eggs of *Ithone fusca* have been introduced, and it remains to be seen whether the larvæ will succeed in establishing themselves under the new conditions, and serve as a help towards controlling the "grass-grubs." The latter are serious pests with but few natural enemies in New Zealand.

THE MAGNIFICENT SPIDER (*Dicrostichus magnificus*, Rainbow).—In the Proceedings of the Royal Society of Queensland (vol. xxxiii. 1921, pp. 91-98, pls. 7 and 8) Mr. H. A. Longman gives an interesting account of this very large and handsome spider. It appears that the creature constructs egg-cocoons of a more or less elongate-fusiform shape, each being suspended by a pedicel attached to a bush. Their total length measures from three to four inches with a maximum diameter of about one inch. The cocoon is double, one cocoon lying within the other, and between them is a loose packing of delicate silk. Within the inner cocoon are the eggs, which number more than 600, and, taking five cocoons as an average, each spider lays about 3000 eggs. After hatching, the young spiders climb up the surrounding leaves and spin fine threads. On the latter they are floated, or ballooned, through the air to start life on their own account. The author gives a detailed account of how this remarkable cocoon is spun by the parent, which, although skilful in this art, had neither the capacity nor inclination to mend a rent in it when it was torn by a cricket-like insect. The spider constructs no web for ensnaring prey, but shortly after sunset it hangs suspended from a horizontal line near its cocoons. From this slender bridge it spins a short filament which hangs downwards and terminates in a globule of viscid matter a little larger than the head of an ordinary pin. The filament is held out by one of the front legs, and, on the approach of an insect, the spider whirls it with surprising speed; this is undoubtedly the way in which it secures its prey. Mr. Longman has repeatedly found the spider sucking a common species of Noctuid moth which it captures in this manner.

IMPROVED RIVER DISCHARGE MEASUREMENTS.—In the measurement of river discharge special difficulties are encountered in the case of sluggish streams such as the Blue Nile at Soba during low water. In a report on "Investigations into the Improvement of River Discharge Measurement," Pt. II. (Government Press, Cairo), Mr. E. B. H. Wade gives the result of his experiments with an improved current meter for streams of this type. It is a helical current meter in which the helix is driven not by the stream but by an independent constant power. The effect of the stream is merely to increase or diminish the rate of the helix by an amount which serves as a measure of the stream's velocity. An instrument on these lines is being constructed by Messrs. Kent and Co. The distinctive feature of the model is that gear is dispensed with, and instead of a weight with one or two kilogrammes falling about thirty centimetres, a weight of 25 to 50 grammes falls a distance of one metre. The good results of this model are said to be due, in large measure, to the directness of its action and the avoidance of dissipation of energy in gear work. Experiments made with instruments of this type gave satisfactory results. The probable error for a single determination was found to be $\pm 0{\cdot}03$ second, but Mr. Wade believes that this will be reduced in the perfected instrument.

TURBULENCE ON A LARGE SCALE.—To say that a gas has viscosity, is a device to compensate in the bulk for the motions which are ignored in detail. Thus if the ignored motions are those within only a cubic tenth of a millimetre the viscosity, for air, is roughly $0{\cdot}0002$ cm.$^{-1}$ grm. sec.$^{-1}$. If, however, we ignore the gusts in a wind, then we must attribute to the smoothed wind a much greater viscosity, ranging, in the same unit, from 1 to 100. In this way the increase and veer of the mean wind in the first kilometre above ground have been explained by Åkerblom, Taylor, Hesselberg, Sverdrup, Schmidt, etc. Recently Albert Defant of Innsbruck has gone a stage further by asking what the viscosity must be if we ignore even the cyclones and anticyclones, so that we are left with a smooth general circulation of the atmosphere proceeding along the paths commonly shown in maps of the globe. A review of Defant's first paper on this subject appeared in NATURE of April 15 last, p. 469. In a second paper, "Die Bestimmung der Turbulenzgrössen der atmosphärischen Zirkulation aussertropischer Breiten" (Wien, *Akad. Wiss.*, 1921), he re-examines, by other methods, the viscosity to be attributed to this general circulation, and finds, as before, values round about 10^8 cm.$^{-1}$ grm. sec.$^{-1}$, that is to say, a billion times as great as that arising by ignoring molecular agitation only. This large value, 10^8, applies to friction across vertical planes, but apparently the friction across horizontal surfaces is an affair of gusts, not of cyclones. When the viscosity is known the conductivity for heat and for water vapour can be found by the theories of G. I. Taylor and W. Schmidt. The methods whereby Defant obtains this viscosity include a computation of "eddy-stresses" in accordance with Osborne Reynolds' theory from the hourly values of the wind at various heights. The direct eddy-stresses are in some cases as big as $0{\cdot}3$ millibar. Defant also makes a determination by way of the scattering of air to north and south of the mean-current after a passage of 3 days, using a formula due to L. F. Richardson.

A Florentine School of Physics and Optics.

By Dr. L. C. MARTIN.

THE city of Florence, deservedly famous as a place of pilgrimage for lovers of art, is no less worthy of a visit on the part of students of science. The famous Museo di Fisica, with its Tribuna di Galilei and its collection of priceless instruments, will always attract the lion's share of attention, but a visit to the charming southern suburb of Arcetri, with the astronomical observatory and the newly erected Institute of Physics and Optics, will amply repay the time spent in making it.

On driving out from the city by the cypress avenue of the Villa Poggio Imperiale, the observatory is seen to the left crowning a lofty hill, on the side of which the red roofs of the Institute can be seen among the green of the surrounding gardens and vineyards. A wide view over the peaceful countryside is obtained on reaching the terrace.

The building is of the square form with centre courtyard usual in Italy, and is only two stories high. A cloister surrounds the courtyard on the ground level, and above the cloister a wide closed corridor affords interconnexion between the rooms on the upper floor. It is commonly held that a similar form of building is not suitable for the British Isles on account of the colder climate, but it may be doubted whether this view is correct; the arrangement has in the present case certainly proved most successful from many points of view. The rooms and corridors are light and airy, while the building is extremely compact and its low height makes for stability. There is little or no trouble from vibration, all machinery being housed in one side of the square at the back of the building. Lastly, and not least, a way has been found to combine beauty with utility, and it was not thought wasteful even in these modern times to follow the charming traditions of Florence by planting a garden to surround the well in the courtyard. This is shown in Fig. 1.

FIG. 1.—The Courtyard of the Physical Institute at Arcetri, Florence.

The Institute was erected immediately after the war to serve for post-graduate and research work in physics and optics. The physical laboratories are under the direction of Prof. A. Garbasso, who, during the last year, has served as Mayor of Florence. The optical laboratory is directed by Prof. A. Occhialini, the well-known editor of the *Revista d' Ottica*. In the coming year it is proposed to build an annexe devoted entirely to technical optics. Up to the present the teaching activity has been restricted to the physical side, but courses on optical subjects are being arranged and research and testing are already in progress. Accommodation is provided for thirty to forty students taking post-graduate courses in physics. The present students are drawn largely from the University of Pisa.

In the course of a short visit it is scarcely possible to notice all the features deserving attention. The arrangement of lecture theatre, class rooms, and research rooms is generally excellent, and it is evident that the needs of experimental work have been considered during design; for example, in one corner of the building it is possible to obtain the equivalent of a vertical circular shaft by removing the coverings of holes in the roof and floors, an arrangement which is of the greatest value in optical testing.

The usual wiring and switchboard for the distribution of electric current is provided, and there is also a separate high-tension circuit. Another point which seems admirable is the construction of the roomy apparatus cupboards in which three sides are of glass; they stand in the corridor on the first floor and exhibit the apparatus to advantage, a matter of importance in a teaching institution.

In the matter of equipment the usual lines have been generously followed. For example, the optical apparatus includes 40 and 20 plate echelons with appropriate spectroscopes, a Fabry and Perot interferometer, and a Nutting spectrophotometer, all by A. Hilger, Ltd. There is also a large spectrometer (with four reading microscopes for the circle) by the Société Genevoise. Other branches of physics seem to be supplied in a corresponding manner. Those who know something of the present cost of equipment of this kind will appreciate the intensity and vigour of the effort which Italy is making in the founding of this Institute.

In Florence as in few other cities one loses that sense of the remoteness of the past which oppresses the mind in more modern surroundings, and the splendour of bygone days seems still our own for guidance and inspiration. Such thoughts find a fitting expression in two frescoes which are seen on leaving the Institute by the main staircase. On the one side is seen Youth in the quietness and cool of the evening drinking of the fountain of ancient wisdom, while opposite we see Humanity in the glory of morning sunlight pressing upwards with eagerness and hope towards the hilltops.

I am indebted to Profs. Occhialini and Garbasso for photographs and information for the purposes of this article.

Fruit-Growing and Research.

THE application of scientific methods and principles is steadily gaining ground in fruit culture as in other branches of agriculture, and the numerous publications on the subject provide evidence of a widening interest in the matter, both as regards the scientific and the practical worker.

The earlier work of Spencer Pickering and the Duke of Bedford stimulated interest in the root systems of fruit trees, and at Long Ashton [1] the matter of root development under various conditions is being followed up. It appears that the method of treatment at the time of planting has little effect on the type of root produced, a new root system being derived from the collar region of the tree and little growth occurring elsewhere; aeration is considered to be a dominant factor in determining the actual point of origin of the new roots. Root formation and growth are most active at the beginning and towards the end of the season, the greatest increase in root length occurring during the latter period, at the time when shoot growth is rapidly decreasing. Other experiments deal with the extension of the root system throughout the soil, a matter which has a direct bearing on the degree of overlapping of roots when too close planting is practised.

On the pathological side special attention has been directed to leaf-scorch on fruit trees, and the trouble has been found to be due to various causative agents. Among the chief of these are unfavourable soil conditions, due to deficient food or water supply or to defective aeration owing to the mechanical character of the soil. Scorching is also attributed to the direct action of wind, to excessive heat falling on the leaf, or to injury to the vascular system of the plant, such as may be caused by ringing or by the presence of a fungus which penetrates the vascular tissue and interferes with the water supply to the leaves.

The importance of spraying to combat disease is now widely recognised, and at East Malling [2] direct experimental work is being carried out with fungicides on apple trees. Every fungicide tested reduces apple scab (*Venturia inæqualis*), though the degree of effectiveness varies, Bordeaux mixture usually proving the best. Generally speaking, the crop and the size of the fruit are improved by spraying, with certain exceptions, and there are indications that summer spraying may improve the keeping quality of the fruit by reducing attacks of brown-rot (*Sclerotinia fructigens*). An interesting point is that the effects of spraying are cumulative, sprayed trees being less heavily affected in the succeeding years.

A critical examination of the stocks used for stone fruits [3] shows that little or no attempt has hitherto been made to group them as has been done for those used for apples and pears, rapidity of growth and general availability being usually the deciding factors in the selection of stocks in any particular instance. The descriptions worked out at East Malling are the beginnings of an attempt to set up a permanent standard of classification and identification with the view of the ultimate improvement of stone fruit cultivation.

In an interesting survey on progress in methods of practical fruit-growing in the Journal of the Royal Agricultural Society of England,[4] the whole business, from the selection of a holding to the final packing of the fruit, is traced. Laying out and planting the fruit farm, raising and selecting trees, pruning, manuring, diseases, and pests are all brought under consideration in a way that provides suggestive reading for all interested in the subject, and its value is enhanced by a useful bibliography. In this connexion also attention may be directed to the collected leaflets [5] on fruit recently reissued by the Ministry of Agriculture, in which various problems the practical fruit-grower encounters in his work receive detailed consideration.

[1] Annual Report of the Agricultural and Horticultural Research Station, Long Ashton, 1921.
[2] Grubb, N. H. (1921), *Journal of Pomology*, II., No. 2.
[3] Hatton, H. G. (1921), *Journal of Pomology*, II., No. 4.
[4] Hatton, H. G., 1921, Journ. Roy. Agric. Soc., England.
[5] Collected Leaflets on Fruit, 1921. Sectional volumes, No. 4. Ministry of Agriculture and Fisheries.

Volcanic Activity in Nigeria.

IN NATURE of July 15, p. 97, an account was given of volcanic activity in Nigeria during March-May last. The following extracts, from the reports of Mr. H. S. Cameron, acting Supervisor of Plantations in Nigeria, furnish some later information. They are placed at our disposal through the courtesy of the Colonial Office:—

On June 17 the manager of Bibundi informed me by telephone that lava streams had commenced to flow again; also that heavy damage was being done by floods. On June 18 I went to Bibundi, and going by trolley to Dollmanshöhe I found the roadway of the bridge entirely swept away by floods and also one of the four piers gone. I went up the river, and after about a mile reached the first flow of lava, which had been advancing the day before but had now cooled and was stationary. Crossing from there to Wernerfelde, progress was shortly prevented by advancing lava; the stream here was molten, but its advance, which was more "creeping" than "flowing," was over a very wide area and on a gentle slope, and it seemed probable that eventually it would cool and turn the main lava stream down the old course of the Njonge river and extend into the sea, as part of the flow was then doing.

The flooding damage was considerable and I think unpreventable; the amount of water is so great that it is impossible to direct it. More than fifty inches of rain fell in the first seventeen days of June, and the water from an area which formerly fed three rivers and part of a fourth has now no channel: not only is an exit lacking, but rain falling on lava does not sink in and percolate through but rushes at once to the lowest level, so free drainage is more necessary than ever.

On June 22 I received a letter stating that the lava had broken through near Dollmanshöhe bungalow, followed the course of the stream, and was threatening the hospital, which had been abandoned. On reaching the bridge-end at Dollmanshöhe on June 25, I found that the whole of that division above the iron road had been covered with lava, and cascades of molten lava were flowing down the banks of the ravine. It was really a wonderful sight. The river bed was full of detached flows of lava fed from the Dollmanshöhe plateau, where it had been massing during the past week. I inspected the whole length from near the Thormählenfelde bungalow to the director's house, finding flowing lava everywhere. By afternoon the ravine was filled, and by 11 P.M. the lava had crossed the rail where the Government road turns

off and was advancing down the latter and towards it from various points along the river course on the left.

Owing to the steady progress between June 18 and 25, and the rapid flow on the latter date, I considered it advisable to order the removal of all the machinery and the salving so far as possible of all building materials worth removing from machine house, cacao house, hospital, and director's house.

On July 11 I again visited Bibundi. The lava had advanced considerably since June 25, but its activity is gradually dying out, though the lava streams from the crater, so far as can be seen in this very misty weather, continue as strong as ever. Probably there will be another period of rest and banking up to be followed by a further advance, and everything points to this following the line of the iron road and Government road to the cacao store and machine house, and possibly breaking through the main portion of Thormählenfelde to the Ninonne River higher up.

On July 15 the manager of Bibundi reported: "The main lava stream is quiet; but for the last three nights I have seen a large new stream coming down the mountain. It is very bright and much closer to this side than before."

The Royal Photographic Society's Exhibition.

THE Annual Exhibition of the Royal Photographic Society at 35 Russell Square remains open until October 28. Admission is free. The natural history section of the scientific and technical division has improved considerably in recent years. There are still a good many single photographs of an animal, a flower, or an insect that have no particular interest, or if they have it is not indicated; but there are many series showing progressive changes, such as Dr. S. Hastings's nine illustrations of soil formation in the Alps, in which he shows the bare rock covered at first with crustaceous lichens, and traces the stages of vegetation until an alpine meadow is produced. Other series show many varieties of the same kind of thing, as Mr. C. H. Caffyn's thirty sections of calcareous, arenaceous, and igneous rocks, and Dr. Rodman's animal and vegetable hairs. With scarcely any exception the photography in this section is excellent.

Among the "Technical Applications of Photography" Dr. J. S. Plaskett shows four photographs taken at the focus of the 72-inch reflecting telescope at the Dominion Astrophysical Observatory, Victoria, B.C., which also give evidence of the accuracy of figure of the mirror. The Mount Wilson Observatory, Carnegie Institution of Washington, contributes specimens of the work of the 100-inch Hooker reflector and of the 60-inch reflector, as well as photographs of the unusual spectra of seven stars, made with these instruments. Enlarged negative prints of a latitude variation plate and a wave-length plate are among the exhibits of the Astronomer Royal, Greenwich.

The production of accurate comparative scales by photographic means is fully described and illustrated by Mr. A. E. Bawtree, and Mr. Wilfred Mark Webb shows how, by chemical and photographic means, a Russian internal passport was made to yield deleted details which showed that the document had done duty on four separate occasions for as many different persons.

Mr. G. A. Clarke illustrates upper cloud formations which support the theory of Prof. Bjerknes that depressions have their origin in the meeting of a warm, moist, equatorial current and a cold, dry, polar current. Cloud formation and structure is shown from the upper side by Mr. F. W. Baker.

There are many exhibits that deal with the technicalities of gelatine plate manufacture and the statistical properties of plates by workers in America, as well as in this country. We may refer specially to the beautiful photomicrographs of silver bromide crystals, at 3000 diameters, by Mr. A. P. H. Trivelli, and the characteristic curves of modern high-speed dry plates with photomicrographs of the grains that constitute the sensitive material by Mr. J. W. Grundy. Mr. Grundy also contributes a fine series of photographs taken under various conditions from a height of about 14,000 feet.

Among numerous radiographs by several workers the effect of the Potter-Bucky diaphragm is shown by Mr. R. B. Wilsey. This diaphragm consists of a grid made of parallel strips of lead foil, the planes of which are in line with the direction of the radiation from the tube. It is placed between the patient and the film, and moved during the exposure so that it may not show on the radiograph; it absorbs a large proportion of the scattered rays.

There is a large collection of colour transparencies, and among them some of scientific interest, but the most remarkable are the stereoscopic slides made on autochrome plates by Mr. S. Pegler. The successful reproduction of the colour and the brilliancy of silver plate, various articles of jewellery, and coloured stones, together with the realistic appearance, demonstrates possibilities of this method that are little known.

C. J.

University and Educational Intelligence.

LONDON.—The senate of the university includes sixteen members elected by registered members of convocation and sixteen by the faculties. Of the former, six are elected by the registered graduates in science; and of the latter, the faculty of science appoints four. There are two vacant seats in science, and five candidates have presented themselves as candidates for them. The candidates are: Dr. George Senter, principal of Birkbeck College, and author of a number of papers and other works on chemistry (Dr. Senter is a member of the faculty of science, and is therefore eligible for election as a representative of the faculty in the senate); Mr. T. Ll. Humberstone, an old student and associate of the Royal College of Science, well known to be particularly familiar with the work of the University and educational problems generally; Dr. Jessie White, who is especially interested in methods of teaching science; Dr. J. S. Bridges, director of education, Willesden; and Mr. C. W. Crook, headmaster, Central Secondary School, Wood Green. The poll closes on Tuesday next, Oct. 10, and it is hoped that graduates will not fail to send in their voting papers before that date.

ST. ANDREWS.—The honorary degree of LL.D. was conferred upon the Prince of Wales on September 28. In an address to his Royal Highness after the presentation, Dr. J. C. Irvine, principal of the university, reminded him that St. Andrews was not only a place of beauty and the home of a noble game, but also a centre from which great movements had sprung and powerful influences had spread far and wide. The ancient university was ever ready to enlarge its activities, blending the wisdom of the past with the spirit of progress.

Calendar of Industrial Pioneers.

October 8, 1862. James Walker died.—An eminent civil engineer, Walker constructed many works of the greatest magnitude, and as engineer to the board of the Trinity House built the Bishop's Rock Lighthouse and the Smalls Lighthouse. In 1834 he succeeded Telford as president of the Institution of Civil Engineers, and held that position for eleven years.

October 9, 1902. George Wightwick Rendel died.—Born in 1833, Rendel was the second son of James Meadows Rendel. Trained under his father, he gained experience in bridge building in India, and in 1858 became a partner with Armstrong at Elswick, where, with Andrew Noble, he directed the ordnance works for twenty-four years. He was intimately associated with the development of the hydraulic system of gun mountings—the first mounting being fitted in H.M.S. *Thunderer* in 1877—and he was also a pioneer in the application of forced draught to warships. From 1882 to 1885 he was a civil lord of the Admiralty.

October 10, 1854. John Augustus Lloyd died.—At an early age Lloyd left England for South America, where he became an officer in the army of Bolivar. In 1827 he made a survey of the Isthmus of Panama. From 1831 to 1849 he was colonial engineer and surveyer of Mauritius, where he constructed many roads and bridges, a patent slip for ships, a break-water, and the colonial observatory. Among his writings was a paper read to the Institution of Civil Engineers on "Facilities for a Ship Canal between the Atlantic and Pacific." He died in the Crimea while on a Government Commission.

October 11, 1705. Guillaume Amontons died.—Employed for many years on public works in France, Amontons was a member of the Paris Academy of Sciences, and was known for his improvements in barometers and other instruments. In 1684 he suggested a means of signalling long distances by a type of semaphore telegraph.

October 12, 1859. Robert Stephenson died.—The only son of George Stephenson, whom he assisted in the construction of the Liverpool and Manchester Railway, which was opened in 1830, Robert Stephenson became engineer to many of the early railways. Among his most famous works were the High Level Bridge at Newcastle, the Tubular Bridge over the Menai Straits, and the Victoria Bridge at Montreal. He was elected a fellow of the Royal Society in 1849, and during 1856–57 served as president of the Institution of Civil Engineers. He was buried beside Telford in the nave of Westminster Abbey.

October 13, 1902. Peter Brotherhood died.—After studying at King's College, London, Brotherhood worked as a mechanical engineer at Swindon and at Maudslay's, Lambeth; in 1867 he set up in business for himself in London. In 1872 he introduced the three-cylinder engine adopted extensively for torpedoes, and in 1875 built the first steam engine coupled direct to a dynamo—this being fitted in the French battleship *Richelieu*. He also made many improvements in air-compressing machinery.

October 14, 1906. Sir Richard Tangye died.—One of the five brothers who built up one of the most important engineering works in Birmingham, Tangye and his brothers migrated to that city from Redruth. Setting up as tool and machine makers, they made a reputation by the construction of the hydraulic jacks by means of which Brunel launched the *Great Eastern*, and they afterwards became known all over the world as the makers of steam engines and pumping machinery. E. C. S.

Societies and Academies.

SWANSEA.

Institute of Metals, September 21.—J. E. **Clennell**: Experiments on the oxide method of determining aluminium (Report to the Aluminium Corrosion Research Sub-Committee of the Corrosion Research Committee of the Institute). It was desired to find a direct method of determining aluminium in presence of iron and other impurities. Precipitating aluminium as hydroxide by alkali thiosulphates was fairly satisfactory, but the weight of precipitate generally exceeded the theoretical amount calculated from the aluminium known to be present. This excess was traced to small quantities of absorbed substances, notably salts of iron and sulphates, probably of aluminium. A better method is as follows: Pass sulphur dioxide through the slightly ammoniacal solution, precipitating in dilute, faintly acid, boiling solution with sodium thiosulphate with addition of dilute acetic acid, washing by decantation with hot 1 per cent. ammonium chloride, filtering and washing with hot water. Iron, zinc, manganese, and magnesium in ordinary amounts do not interfere, but when the first two are present in large quantity a double precipitation is necessary.—Marie L. V. **Gayler**: The constitution and age-hardening of alloys of aluminium with copper, magnesium, and silicon in the solid state. *Constitution.*—These alloys have been regarded as a ternary system since magnesium and silicon are added in the proportions of the compound magnesium silicide, which is very stable at all temperatures. Microscopic examination shows that the solubility of copper is reduced from 4·5 per cent. to 2 per cent. at 500° C. by the presence of 0·7 per cent. magnesium silicide; while 2 per cent. of copper reduces the solubility of magnesium silicide from 1·2 per cent. to 0·7 per cent. at 500° C. At 250° C. both constituents are turned out of solution when only 0·5 per cent. of each are present. *Age-Hardening.*—Brinell hardness measurements were made on alloys in which the percentage content of one constituent only was varied; they were quenched from 500° C. and allowed to age-harden at room temperature. Age-hardening is due to the difference in solubility at high and low temperatures of both copper and magnesium silicide, and the solubility in aluminium of both in the presence of each other. Heat treatment of age-hardened alloys caused a preliminary softening before an increase in hardness; this is probably due to the process by which both compounds tend to come out of solution. Derived differential curves of alloys which had been quenched, but not aged, show three critical points; the lowest is at a constant temperature; the temperature of the two upper critical points is lowered with increasing copper content; the intensity of the uppermost varies with the copper content. Probably this point is due to the precipitation of the copper compound and the second to the precipitation of magnesium silicide.—D. **Stockdale**: The copper-rich aluminium-copper alloys. Alloys of copper with aluminium up to 20 per cent. of aluminium have been investigated. Thermal data from the cooling-curves and from quenching experiments in conjunction with microscopic examination were used to obtain equilibrium diagrams. The minimum in the liquidus curve at 1031° C. with 8·3 per cent. of aluminium is a true eutectic point; a small arrest point at 1017° with alloys containing between 16·5 and 18 per cent. of aluminium has been discovered. Copper at 1000° C. can hold only 7·4 per cent. of aluminium in solid solution; at 500° C. and at lower temperatures, 9·8 per cent., although to obtain such an alloy a

long annealing is required.—**R. Seligman** and **P. Williams**: Cleaning aluminium utensils. Aluminium is not attacked by water-glass solutions or by hot soda solution containing a little sodium silicate. Attack by a 5 per cent. soda solution is immediately arrested by the addition of an amount of sodium silicate equal to 1/100 of the soda. Satisfactory detergents consisting of a mixture of soda and sodium silicate are articles of commerce; among them are "Carbosil," "Pearl Dust," and "Aquamol."—**W. Rosenhain** and **J. D. Grogan**: The effects of overheating and melting on aluminium. Exposure to an unduly high temperature during melting, and repeated re-melting even at ordinary melting temperatures, are thought to cause deterioration approximating to the condition generally described as "burnt" aluminium. High-grade aluminium was poured at temperatures up to 1000° C. and also at the usual pouring temperature after heating for some hours at 1000° C. The castings rolled and tested in the annealed state showed no deterioration. High-grade aluminium and also aluminium containing ½ per cent. each of iron and silicon were cast to ½-in. slabs and rolled to 0·01 in. sheet; the sheet was re-melted and the process repeated ten times. Test pieces from each melt showed no systematic change.

SYDNEY.

Linnean Society of New South Wales, July 26.—Mr. G. A. Waterhouse, president, in the chair.—**A. E. Shaw**: Description of new Australasian Blattidae, with a note on the blattid coxa. Nine cockroaches are described as new, three belonging to Platyzosteria, five to Cutilia, and one doubtfully to Zonioploca.—**H. H. Karny**: A remarkable new gall-thrips from Australia. These thrips infest the branchlets of the "Belah" (*Casuarina Cambagei*) and cause rounded galls of aborted tissue to form, in which large colonies of thrips develop.—**G. F. Hill**: A new Australian termite. The new species of Calotermes from near Condon, W.A., is distinct from any described Australian species and easily distinguished in the soldier caste by the long narrow head, large mandibles, dentition, third joint of antennæ, and enlarged femora.—**E. W. Ferguson** and **G. F. Hill**: Notes on Australian Tabanidæ, part ii. Eight new species, including 1 species of Silvius and 7 of Tabanus, and two varieties of species of Tabanus are described.—**J. McLuckie**: Studies in symbiosis, part ii. The apogeotropic roots of *Macrozamia spiralis* and their physiological significance. Root-tubercles occur upon many of the seedlings and older plants of *Macrozamia spiralis*, particularly about the soil-level. They are seldom present on the more deeply situated secondary roots, but may be induced to develop by artificial inoculation. The root-tubercles are due to infection by soil bacteria, the presence of which stimulates the development of the cortex and sheath, so that the tubercles are more massive than ordinary roots.

Official Publications Received.

Proceedings of the South London Entomological and Natural History Society 1921–22. Pp. xvii + 83. (London: Hibernia Chambers, London Bridge.) 5*s*.

Merchant Venturers' Technical College. Calendar for the 67th Session, 1922–23. Pp. 54. (Bristol.) 6*d*.

Ministerio da Agricultura, Industria e Commercio: Directoria de Meteorologia. Boletim Meteorologico: Anno de 1912. Pp. 110. Boletim Meteorologico: Anno de 1913. Pp. 130. (Rio de Janeiro.)

Papers of the Peabody Museum of American Archæology and Ethnology, Harvard University. Vol. 8, No. 3: The Turner Group of Earthworks, Hamilton County, Ohio. By Charles C. Willoughby; with Notes on the Skeletal Remains, by Earnest A. Hooton. Pp. viii+132+27 plates. (Cambridge, Mass.)

Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium. Vol. 23, Part 2: Trees and Shrubs of Mexico (Fagaceæ–Fabaceæ). By Paul C. Standley. Pp. xxxvii+171-515. (Washington: Government Printing Office.)

Memoirs of the Department of Agriculture in India. Entomological Series, Vol. 7, No. 7: New and Rare Indian Odonata in the Pusa Collection. By Major F. C. Fraser. Pp. 39-81. (Calcutta: Thacker, Spink and Co.; London: W. Thacker and Co.) 1.4 rupees; 1*s*. 9*d*.

Annual Report of the Meteorological Observatory of the Government-General of Chosen for the Year 1918. (Results of Observations.) Pp. iv+134. For the Year 1919. (Results of Observations. Pp. iv+143. (Jinsen.)

Sixth Annual Report of the National Research Council. Pp. 72. (Washington: Government Printing Office.)

Diary of Societies.

MONDAY, OCTOBER 9.

INSTITUTE OF BREWING.—S. K. Thorpe, and others: Discussion on the Expenses incurred in connection with the Shipment of Foreign Barleys.

ROYAL SOCIETY OF MEDICINE (War Section) (at Royal Army Medical College, Millbank), at 5.—Lt.-Gen. Sir John Goodwin: Presidential Address.

TUESDAY, OCTOBER 10.

ROYAL SOCIETY OF MEDICINE (Therapeutics and Pharmacology Section), at 4.30.—Dr. W. Langdon Brown: The Problems of Asthma (Presidential Address).—Dr. T. Izod Bennett: The Modification of Gastric Function by means of Drugs.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Chemical Society), at 5.30.—Dr. A. E. Dunstan: The Work of the Standardization Committee.

INSTITUTE OF MARINE ENGINEERS, INC., at 6.30.—A. Keenes: Conditions to get High Economy from Oil Fuel.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—F. Martin Duncan: Crustacea.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 8.—Dr. R. S. Clay: The Development of the Photographic Lens from the Historical Point of View (the Twenty-fifth Annual Traill-Taylor Memorial Lecture).

INSTITUTION OF HEATING AND VENTILATING ENGINEERS, INC. (at Caxton Hall), at 8.15.—R. Fortune: Some Points in the Law of Heating Engineers' Contracts.

WEDNESDAY, OCTOBER 11.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS, INC. (at Caxton Hall), at 3.—J. L. Musgrave: Heating and Ventilating of Passenger Ships.

ROYAL MICROSCOPICAL SOCIETY (at Examination Hall, 8-11 Queen Square, W.C.1), at 7.30.—A Conversazione.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Automobile Club), at 8.—Lt.-Col. D. J. Smith: Presidential Address.

THURSDAY, OCTOBER 12.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—Dr. L. C. Martin: A Physical Study of Coma.—F. W. Preston: The Structure of Sand-blasted and Ground Glass Surfaces.

INSTITUTE OF METALS (London Section) (at Institute of Marine Engineers), at 8.—Dr. D. Hanson: Chairman's Address.

ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—Dr. W. Harris: Toxic Polyneuritis (Presidential Address).

FRIDAY, OCTOBER 13.

ASSOCIATION OF ECONOMIC BIOLOGISTS (in Botanical Lecture Theatre Imperial College of Science), at 2.30.—Dr. E. J. Butler: Virus Diseases in Plants.—Dr. J. A. Arkwright: Virus Diseases in Animals and Man.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.

—— (Ophthalmology Section), at 8.30.—N. Bishop Harman: A Visual Standard for School Teachers.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—E. C. West: Artificial Ice Making.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 8.—Dr. C. A. Swan: Carcassonne and the Pyrenees.

PUBLIC LECTURES.

MONDAY, OCTOBER 9.

UNIVERSITY COLLEGE, at 5.—Prof. G. Elliot Smith: The Beginnings of Science.

KING'S COLLEGE, at 5.30.—Prof. G. B. Jeffery: Einstein's Theory of Relativity.

TUESDAY, OCTOBER 10.

UNIVERSITY COLLEGE, at 5.—Prof. C. Spearman: The Nature of Intelligence.

WEDNESDAY, OCTOBER 11.

UNIVERSITY COLLEGE, at 5.30.—Miss A. S. Cooke, Col. J. M. Mitchell, and Capt. R. Wright: Discussion on Recent Developments in Rural Library Work.—Miss Lilias Armstrong: The Use of Phonetics in the Class Room. (As applied to the teaching of French.)

BEDFORD COLLEGE FOR WOMEN, at 5.30.—Prof. E. A. Gardner: Delphi and Delos.

UNIVERSITY COLLEGE, at 7.—A. H. Barker: Standard Ratings for Radiators, Boilers, and Complete Heating Installations.

THURSDAY, OCTOBER 12.

CITY OF LONDON Y.M.C.A. (186 Aldersgate Street), at 6.—Sir Arthur E. Shipley: Fleas, Flies, and Mosquitoes.

SATURDAY, OCTOBER 14.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. Shaw: Flight in all Ages.

SATURDAY, OCTOBER 14, 1922

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Landowners and the State.

LORD BLEDISLOE, as president of the Agricultural Section of the British Association at Hull this year, struck a new note in his address. Put very briefly, his text was a demand for more leadership, and in particular for educated leadership by landowners in the business of farming. British farming has for the last two centuries in the main been carried on by tenants possessed of considerable capital, which is employed in the business and not in the land itself nor in its permanent equipment. The result, at any rate until fifty years ago, was successful. Complicated as the question of tenure was in detail, by custom it worked well on the whole; a sufficiency of capital was attracted to the land to permit of cultivation on a comparatively large scale with sufficient continuity to encourage experiment and improvement, until British farming, whether as regards operations of cultivation, productivity of crops grown or quality of stock bred, stood easily foremost in the whole world.

British agriculture no longer enjoys the same undisputed position. We can still point with pride to its technical excellence, but it has not succeeded in so adapting itself to the changed economic conditions as to continue to be regarded as a prosperous industry or to attract the confidence of capitalists. Farmers, despite some protestations, can still make a living out of it, because they can always adjust their style of farming to any range of prices, but the position of the other two parties to the occupation of the land is far from satisfactory. Landowners' rents do not represent a reasonable rate of interest on the money that has been expended on the buildings, etc. necessary to the working of the farm. A piece of average English land in prairie condition could not to-day be equipped as a farm and then let at a rent which would pay market interest on the capital expended in equipping it, even though no charge were made for the land itself. Landowners who sold their farms during the last few years were able after reinvestment to double and treble the income they had derived from them, and at the same time to relieve themselves of many of the calls upon the landlord's purse. Agricultural labourers, again, though they effected some improvement in their position during the war, are still the worst paid industrial class of any magnitude in the community. In the villages it is well recognised that a boy is likely to be better off if he can get on the railway, into the police, or any of the other occupations more or less available, rather than go upon the land.

The tenant-farming system, for all its advantages, appears to be breaking down, and Lord Bledisloe regards the landowners of the last generation or two

as in part responsible. From an abstract point of view the ordinary English tenant farm of 200 to 500 acres is no longer the economic unit it once was. At its inception it represented wholesale large scale production as compared with the generality of European farming, and as such it provided the food needed for the early industrial development of the country.

But with the enormous extension of wheat growing and meat production in the newer countries, the effect of which upon our markets began to become so apparent from the 'seventies of last century onwards, and with modern organisation of the import trade in food products from countries with a low wage standard, the English farmer no longer controls prices, and when he stands alone, he is selling as a retailer in a market dominated by much larger interests. It has become a terribly difficult market because Great Britain is now the one absolutely free emporium to which the surplus food products from every other food-producing country in the world are directed. With one or two minor exceptions (Denmark and Belgium are practically free-trade countries, but they are normally food exporters rather than buyers), the British farmer is met by a tariff wall whenever he has a surplus to export or a speciality to develop, and these difficulties are, at the moment, accentuated by the break in the Continental exchanges, which diverts to Britain even the limited quantities of food-stuffs the foreign industrialist had begun to purchase.

Some of these difficulties may be overcome by co-operation, never an easy matter to organise in a conservative community such as our farmers form, bred as they have been in an individualist organisation of business and imbued with the characteristic British tradition of standing alone. In any case, co-operation may be only a palliative; the economic flaw in the tenant-farming system probably is that the unit of management is too small. There is not work for a master in controlling the five to ten men employed on the ordinary English farm; as a managing head one man should be able to supervise the working of 1000 to 2000 acres, according to the class of land. Economic pressure would thus appear to be tending to move away from the present type of British farm in two directions, either towards the single-man holding, uneconomic as an instrument of production but in which compensation is found in the extra labour the occupier will give in exchange for his independence, or on the other hand, towards the really large farm which can take advantage of machinery and organisation.

Lord Bledisloe's main contention is that the landowner must either take the latter option and become the instructed business head of his estate treated as a single farm, or if he prefers not to take over the actual management, he must at least be the leader and *entrepreneur* of the associated businesses of his tenants. Not only is the holding of land a bad investment, but in a modern State the mere rent receiver will eventually be eliminated. Landlords must give service or perish as such, and Lord Bledisloe appeals to a class which has a long and honourable tradition behind it of service to the State to return to the land and so render a necessary service to a State that is becoming overweighted on the industrial side. He points out the two directions in which the landowner can lead his tenants and benefit both his estate and the course of agriculture. In the first place, the farmer to-day is not getting his fair share of the prices the consumer pays for food. While all the producing interests connected with the land are unprosperous and are being forced to contract their activities, the trading organisations which deal in the produce of land are paying handsome dividends and individual middlemen are growing rich. The consumer reviles the farmer because of the scarcity of food; the farmer knows he must restrict his production in order to make it pay at present prices, while the slightest production above the normal demand cuts away not merely profits but often cash returns, as may be seen over plums and potatoes at the moment. The distributing trade has entrenched itself in order to retain its war scale of margin, and the building famine in the country hinders the growth of competition. Lord Bledisloe gives a series of tables to show the discrepancy between retail and farmers' prices and the increase of that discrepancy since the war; in most cases the distributing trades take more than half the price the public pays. Coarse 'middlings' cost more than wheat, and readers of the *Times* a few days ago may have noticed that on the same day the price of London flour was put up while wheat was, in another column, reported as cheaper.

It is to this state of things Lord Bledisloe recommends landowners to turn their attention; can they not organise the businesses of their farmers into something capable of keeping the middlemen in check? They should be able to see further than the farmer, who has to look after his own business of production. Co-operation has made but little headway among farmers themselves; would it not be in a very different position if it had been whole-heartedly and intelligently backed by the landowners? Here is one opening for intelligence and leadership on the part of owners of land.

The other great opening is in connexion with education and research. The old race of landlords numbered among them great improvers of farming, such as Weston, Townshend, Coke, and Lawes. Even the much-abused farming covenants represented, to begin

with, better systems imposed upon their tenants by landlords. To-day, if English farming practice is in many respects still ahead of its competitors, it has become, comparatively speaking, not so alive to the applications of science. Farmers themselves are not quite what they were; the great industrial development of the last sixty years has been drawing away the brains from the more slowly moving pursuit of agriculture, and, speaking broadly, the present race of farmers are not educated up to their needs or their opportunities.

Here again the landowners have not been, but can be, leaders; they can become intelligence centres, they can stimulate the education of their tenants and of their tenants' sons, they can even insist on education in selecting their tenants. It is the lack of appreciation of science among landowners that has made it a plant of slow growth among their tenants.

The address is really a powerfully worded appeal from Lord Bledisloe to the landowning class to treat landowning as a vocation and to educate themselves for it. It is a far-sighted call for service, and coming from one who has so notably put into practice what he preaches, carries with it an authority which no ordinary admonition to progress can possess.

Bergson and Einstein.

Durée et Simultanéité: À propos de la théorie d'Einstein. Par Henri Bergson. Pp. viii + 245. (Paris: Félix Alcan, 1922.) 8 francs net.

EINSTEIN in his theory of relativity may be said to have thrown down a challenge in the scientific world of the same kind as that which Bergson in his theory of duration has thrown down in the philosophic world. Both theories are primarily concerned with a certain fundamental character in the experience of time. Both recognise a difference of nature, that is, a qualitative difference, between the time which enters into our equations of measurement and the time which is lived. At one point, however, Bergson seems to come into direct conflict with the Minkowski-Einstein scheme of a space-time continuum. This is in his conception of creative evolution. Creation means that the reality of the physical universe is of the nature of life or consciousness, a conception which implies the continued existence of the past in the present, and a universal moving forward into an open future. How is this consistent with the view that there is not one single universal time but as many different times as there are systems, and that there is no absolute simultaneity between events which take place at any two points if they are separate from one another in space?

Bergson has evidently been of opinion that for his own sake he must clear up his position on this crucial point. To do so has been no slight undertaking, for he has not been content to accept the principle of relativity from the physicists or to assume that its mathematics is correct. He has, therefore, deferred the resumption of his own philosophical work, interrupted by the war, and has set himself to study at first hand the mathematical equations of Lorentz and Einstein. It may interest readers of NATURE to know that Bergson specialised in mathematics in his student days to the extent of hesitating between it and philosophy when he had to choose a profession. The argument in his new work deals almost exclusively with the restricted theory, for it is that which affects directly the question of the reality of time. The relevance of the generalised theory is only touched upon. It is the subject of a "Final Remark," in which the nature of its importance for philosophy is indicated, but general relativity does not seem to Bergson to challenge, as the restricted relativity does, his theory that time as a universal flux or change is an intuited reality, while successive states are a spatialised time due to the intellectual mode of apprehending it.

Descartes in the Principles (ii. 29) declares that in movement there is complete reciprocity; either of two objects changing their relative position may be considered as having moved or as having remained at rest. To this Sir Henry More replied (March 5, 1649): "When I am sitting still, and someone moving away a mile from me is red with fatigue, it is he who moves and I who am still." Nothing science can affirm concerning the relativity of perceived movement, measured by foot-rules and clocks, can disturb the inward feeling we have that we ourselves can effect movements and that the efforts we put forth in doing so are under our control. Here we have, then, in the most striking manner, the contrast between the intuitive mode and the intellectual mode of apprehending reality. Is there anything in the principle of relativity which conflicts with the conception of reality as fundamentally a duration which is intuited or lived? *Prima facie*, yes. The denial of absolute simultaneity seems completely inconsistent with it. This comes out most clearly in Einstein's paradox. "Suppose a traveller to be enclosed in a cannon-ball and projected from the earth with a velocity amounting to a twenty-thousandth of the velocity of light; suppose him to meet a star and be returned to earth; he will find when he leaves the cannon-ball that if he has been absent two years, the world in his absence has aged two hundred years." Any one who applies the mathematics of relativity and makes the simple calculation for the two systems, earth and cannon-ball, will find that the conclusion

follows with the same logical necessity as in Zeno's paradox that Achilles cannot overtake the tortoise.

There is, however, a limitation even for the relativist which, although it falls short of establishing an absolute, is important to keep in mind. There is no system of reference which a traveller can choose, by entering which he might depart and return to find the world younger, so that his journey would have been backward in time. The reason is not the inconceivability of such a system, but the fact that it would bring us into conflict with the law of causality. The reversibility of causality which would require the effect to come into existence before the cause, is unthinkable. Such then is the paradox. Relativity requires that as we pass into a new system of reference the relative movement of the new system shall be compensated by changes in the spatio-temporal axes of co-ordination in order to keep constant the velocity of light. This means in the case supposed that two years of the one system is the equivalent of two hundred of the other.

Bergson's solution of Einstein's paradox follows the same line as his solution of the paradoxes of Zeno, but the special application of his principle has a particular interest. In the case of Zeno the essential point was the insistence on the continuity, in the meaning of absolute indivisibility, of true duration, the duration which is lived and intuited, as distinct from the infinitely divisible continuity, mathematically defined, of the schematised trajectory of the movement. The mathematical time which we measure is really space. In the case of Einstein's paradox Bergson argues that the two systems, which are discordant as to their simultaneity when taken as integral systems, must be considered as continuously related, and this is possible only so long as we do not abstract from the observer who is attached to each. If, he says, we consider the two observers in their different systems to be continuously in communication it is clear that each, while regarding the other as a physicist co-ordinating a system, will regard that co-ordinated system from the standpoint of his own, and therefore, however different the system may be, in so far as the two observers are physicists and in so far as they are related observers, the duration intuited is one and the same for both. But here we shall ask, if the explanation is so simple, how does the paradox arise? Quite naturally, Bergson replies, and this is the striking part of his argument, because what the philosopher can do the physicist cannot. The philosopher's concern is with reality perceived or perceptible; he, therefore, can never lose sight of the interchangeability of the two systems. He keeps them together by a kind of continual coming and going between them. The physicist, on the other hand, whose only business is to co-ordinate the system as a whole, must choose one and stand by his choice. He cannot relate all the events of the universe to two systems of different axes of co-ordination at one and the same time. He must therefore regard the whole system as concordant or discordant with the whole of the other system, each taken as one and integral. For the physicist is not concerned with time intuited but only with time as a measurable dimension.

We may see, then, how Einstein is able to affirm that there are multiple times. We can place an imaginary physicist at every point of space and his time-system will necessarily be different from every other time-system; and our own time-system, so far as we are physicists, has no privilege over the imaginary time-systems. But, Bergson replies, into whichever of these imaginary time-systems we project ourselves, it becomes thereby time lived or intuited, and as we can conceive ourselves to pass into any of them, there is a real duration to which all the imaginary time-systems belong. Thus is restored to us the unique time, one and universal.

Such is Bergson's solution. Does it dispose of the problem? The argument is certainly calculated to reassure those who have been disturbed by the principle of relativity, and to comfort those who are made unhappy, rather than stimulated to activity, by paradox. Yet there are many indications in his book that Bergson himself does not feel he has said or is now saying the last word. In the final remark, to which we have already referred, he regards the generalised theory as an extension of the argument of the restricted theory with the difference that the emphasis is on space rather than on time. He suggests that the treatment of space on the same lines as those on which he has dealt with time would show that the multiple geometries are imaginary physicists' geometries abstracted from their relation to and transformability into the one and universal space-system which is the intuition of the living individual.

To a certain extent he is undoubtedly right, for we may say truly that the restricted relativity is a case in point of the generalised relativity. But there is a problem which Bergson has left untouched while giving indications that he is aware of it. This is the relativity of magnitudes. Even Einstein has not, so far, dealt with it specifically. Weyl, in his endeavour to make the generalised theory include the whole realm of electro-magnetic phenomena, has foreshadowed a relativity even more fundamental and more universal than Einstein's, although so far he has found no means, such as Einstein found, of submitting the principle to experimental tests. In philosophy it is of the deepest significance. Not only is there no

absolute criterion of magnitude, but systems of reference are not even relatively in relations of magnitude to one another. It is only for the observer in a system of reference that there is a relation of magnitude within the system and that the system itself has relations of magnitude to other systems. Into whatever system an observer passes he carries into it his own constant norm of magnitude and he does not have to submit to the dimensions which the new system imposes on him. It is this aspect of the principle of relativity which has seemed to the present writer to require a philosophical principle like that of the Leibnizian monad to give it full expression. It is not enough to return to the mathematical principle of Descartes's mechanism. Mathematics and physics alike rest ultimately on the experience of active subjects, and this is why experimental tests are relevant. The monadic conception derives new meaning from the theory of reality as psychical duration, the concept which Bergson has made a new possession of human thought.

H. WILDON CARR.

The Molecular Scattering of Light.

Molecular Diffraction of Light. By Prof. C. V. Raman. Pp. x+103. (Calcutta: University of Calcutta, 1922.)

READERS of NATURE are already familiar with the important work which Prof. C. V. Raman has been carrying out in connexion with the scattering of light by small particles, for many of his results have been announced in these columns. In a small volume published by the University of Calcutta he has reviewed the present position of the subject of molecular diffraction of light, and has discussed the theory in a comprehensive survey which includes the case of gases, vapours, liquids, crystals, and amorphous solids.

Lord Rayleigh was the first to indicate the principles on which the problem may be handled, and he obtained a relation between the scattering power of the molecules of a gas, their number per unit volume, and the refractivity of the medium. As the energy scattered must be derived from the primary beam, the intensity of the latter must suffer an attenuation as it passes through the medium, and an expression can be derived for the attenuation coefficient. Prof. Raman discusses some criticisms of the theory and concludes that the principle of random phase which is assumed in the argument is justified, provided there exists the random distribution of the molecules which is required by Boyle's law. The ultimate justification of the principle rests on the complete non-uniformity in the spatial distribution of the molecules in so far as very small volume elements are concerned.

The first successful attempt to observe the scattering of light by dust-free air in the laboratory was made by Cabannes in 1915. Experimental work of great interest has been carried out by Prof. R. J. Strutt (the present Lord Rayleigh), who obtained the remarkable result that, in many gases, the scattered light is only partially polarised. This may be explained as due to the lack of symmetry of the molecules, and may furnish valuable information with regard to molecular configuration.

To the late Lord Rayleigh we owe the brilliant suggestion that the scattering of light by the molecules of air accounted in large measure both for the blue light of the sky and the observed degree of transparency of the atmosphere. Recent observations, principally at the Observatory on Mount Wilson, have confirmed the theory and have furnished a value for Avogadro's constant which is practically identical with that deduced from Millikan's measurements of the electronic charge. Prof. Raman has made observations on the polarisation of skylight on Mount Dodabetta (8750 feet above sea level) in the Nilgiris. As is well known, dust and haze are largely confined to the lower levels of the atmosphere. The influence of secondary scattering may be reduced very considerably by using a deep red filter, and allowance can be made for the effect of earthshine. The weaker component of polarisation was found to have 13 per cent. of the intensity of the stronger component. Only 4 per cent., however, was ascribable to molecular anisotropy, a result in good agreement with the latest laboratory measurements.

The principle of random phase on which Rayleigh's theory depends is not applicable in the case of highly condensed media such as dense vapours, liquids, and solids. In liquids, we may apply the theory developed by Einstein and Smoluchowski, in which scattering is considered not as due to individual particles but to small local variations of density arising from the heat movements of the molecules. A formula is obtained showing how the scattering power of a fluid is related to its refractivity. It is worthy of notice that the scattering power is proportional to the absolute temperature and to the compressibility of the liquid. When corrected for the effect of molecular anisotropy, the formula gives results in fair agreement with observations in non-fluorescent liquids, and it reduces automatically to the Rayleigh formula in the case of gaseous media. But, surprisingly enough, the law seems to break down in the case of gases under high pressure. Prof. Raman makes the interesting suggestion that this failure may mean that the continuous wave theory of light does not strictly represent the facts, and that we may perhaps find here experimental support for Einstein's conception that light itself consists of quantum units.

The colour and polarisation of the light scattered in the sea is discussed by Prof. Raman in a chapter which must interest biologists as well as physicists. The colour of the deep sea is not mainly due to reflected sky-light, as has sometimes been suggested, but to light molecularly diffused from within the water. The reflecting power of water at normal incidence is quite small (only 2 per cent.), and consequently to an observer flying at a great height above the surface of the water the luminosity of the sea would be determined almost entirely by internal scattering.

In crystals such as quartz and rock-salt the scattering of light can be observed visually, the Tyndall cone being of a blue colour. The effect may be attributed to the thermal movement of the atoms in the crystal introducing local fluctuations of optical density. Thus there is a close connexion between this phenomenon and the well-known influence of temperature ("Debye effect") on the intensity of X-ray reflection as illustrated, for example, in the experiments of Sir W. H. Bragg on rock-salt. It may be suggested that further study of the scattering of light in amorphous solids like glass would yield information of value regarding the molecular structure of such bodies.

H. S. A.

Technical Electricity.

(1) *Principles of Electrical Engineering.* By Prof. W. H. Timbie and Prof. Vannevar Bush. Pp. viii + 513. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1922.) 20*s.* net.

(2) *High Voltage Power Transformers.* By W. T. Taylor. Pp. x + 117. (London: Sir I. Pitman and Sons, Ltd., 1922.) 2*s.* 6*d.* net.

(3) *Electric Power Systems.* By W. T. Taylor. Pp. xii + 107. (London: Sir I. Pitman and Sons, Ltd., 1922.) 2*s.* 6*d.* net.

(1) THIS book is intended for students of electrical engineering. Although much of the ground has been covered in a similar way before, yet there are several novel features. The magnetic circuit—the importance of the theory of which in electrical engineering can scarcely be over-estimated—is allotted the space it deserves. The electron theory, which is admirably adapted for giving easily intelligible explanations, is freely used. Thermionic emission, conduction through gases, and electrolytic conduction are all discussed. There are also about 500 practical problems, some of which give interesting engineering data.

The authors divide electrical engineers into three classes. The first class comprises the men who apply scientific laws to electrical development. This includes the research engineer and the designer. The second class includes the distributing engineer who plans, constructs, and operates power-transmission lines, telephone and telegraph circuits, and electric railway systems. There is, finally, the engineer who acts as liaison officer between electrical engineering and civil and mechanical engineering, including all industrial applications. The consulting engineer and the promoting or "commercial" engineer belong to this class. This type of engineer must be well grounded in economics, and well versed in business, law, and procedure.

The authors state that the terminology they use is that recommended by the American Institute of Electrical Engineers. It differs in several important respects from that recommended by the International Electrical Commission. The Gauss is defined as the unit of magnetic induction density. In I.E.C. nomenclature the unit of magnetic induction density is one Maxwell per square centimetre. In Europe the Gauss is defined practically always as the unit of magnetic force. The authors take as the unit of magnetic force "one Gilbert per cm.," and the unit of reluctance is called the "Oersted." We do not think that the Gilbert and the Oersted will be accepted internationally. In our opinion also a case has not been made out for the use of such words as "abohm," "abvolt," "statvolt," etc. Abohm is the unit of resistance in the absolute system of units and "statvolt" is the unit of electric pressure in the electrostatic system of units.

In discussing sparking voltages between spherical electrodes (p. 417), it is stated that "small balls with a given separation break down at a smaller potential than large balls." This is not true in all cases. Russell (Journ. I.E.E., vol. 57, p. 228), for example, states that for half a centimetre spark at 25° C. and 76 cm. the disruptive voltages for spheres of 1 cm., 5 cm., and 25 cm. radius are 17·7, 16·3, and 15·0 kilovolts respectively. It will be seen that the voltages required for a break-down in this case are appreciably higher for the small electrodes. For still smaller-sized electrodes for the same air-gap the disruptive voltages get smaller. Similarly when the air-gap is 1 cm. it can be shown that the sparking voltage has its maximum value of 32 kilovolts when the diameters of the electrodes are each equal to 2 inches very approximately.

(2) Mr. Taylor's book will be of interest to the electrical engineer, as it discusses problems in which he takes great interest. The rating of a transformer, and consequently its price per kilowatt, depends on the "hottest spot" temperature after a full-load run. Considerable space is therefore devoted to methods of keeping transformers cool. It is stated that a cast-iron case will

radiate more heat than one made of boiler-plate, since the roughness increases the surface exposed to the air and to the oil in which the transformer is immersed. This is true so far as the heat conducted from the oil is concerned, but as the great bulk of the heat is carried away by convection currents in the air, it is of importance to increase these currents as much as possible, and so a rough surface may be a disadvantage.

(3) The principles that have to be taken into consideration when designing power systems are discussed. The advantages and disadvantages of the various systems are clearly stated, and will be a help to young engineers. Specimen record forms are given. These are apparently American in origin, as the lineman is warned not to "throw on the current" until he receives the signal. The consumer also gets his lamps free.

Modern Metallurgy.

The Metallurgy of Iron and Steel. Based mainly on the Work and Papers of Sir Robert A. Hadfield. Compiled by the Editor of Pitman's Technical Primers. (Pitman's Technical Primer Series.) Pp. xv+122. (London: Sir I. Pitman and Sons, Ltd., 1922.) 2*s*. 6*d*. net.

THIS small volume, which is written in a very interesting manner, gives the reader a clear idea of the developments made in the metallurgy of iron and steel in recent times. The work contains seven chapters, the first of which deals with the possibilities of an approaching exhaustion of the supplies of both iron ore and coal at some future date; the author, however, points out that, as regards coal, substitution may be arranged by employing the energies of waterfalls, tides, solar radiation, plant life, winds, and finally the enormous power contained in the atoms may some day be released for useful work. Reference is made to the anxiety of the German industrial leaders and others during the Great War of 1914–1918 for the retention of the iron-fields of Northern France, thereby indicating the value that was placed on the commercial prosperity due to iron and steel manufactures.

Chapter 2 contains a brief account of the work of the pioneers in scientific metallurgy. Details are given of the Delhi Pillar, a solid column of nearly pure iron 24 ft. in length and weighing 6½ tons, which was erected about sixteen centuries ago. The author points out that "the finest armour and swords made during the Middle Ages cannot be excelled to-day without using special alloys." Nevertheless, these fine results were obtained empirically, and it was not until recent times that any exact knowledge of the reasons for the various methods of treatment were understood. Tribute is paid in an appendix to the early British workers who have done so much to elucidate these matters, and in more recent years to Faraday, Heath, Percy, Bessemer, Gilchrist, Thomas, Able, Sorby, Lothian Bell, Roberts-Austen, Stead, Arnold, Hadfield, and many others.

Chapter 3 deals with iron ores and the manufacture of iron and steel, while chapter 4 is devoted to hardening, heat treatment, and microstructure. In chapter 5 alloy steels are considered, and here the work of Sir Robert Hadfield is frequently referred to, especially in connexion with nickel and manganese steels. It has been stated by the well-known German writer Mars in "Die Spezialstahle" that: "The most extensive experimental researches, which may be said to have laid the foundation of our entire knowledge of steel alloys, were carried out by Hadfield in the 'eighties of the last century." Reference is also made to the direct and indirect saving effected by alloy steels of low hysteresis discovered by Sir Robert Hadfield about twenty years ago. Mr. T. W. Yensen, of the American Westinghouse Electric Company, estimates that the total saving effected to the world by the use of this material amounts to about 340,000,000 dollars.

Fuel economy and research are dealt with in chapters 6 and 7 respectively, and the work is concluded with two appendices, one containing a list of early workers in scientific metallurgy, and the other a list of research papers and scientific addresses by Sir Robert Hadfield from 1888 to 1921.

The little book is both interesting and useful, and should certainly find a place in every metallurgical library.

W. H. M.

The British Association Addresses of 1922.

The Advancement of Science: 1922. Addresses delivered at the 90th Annual Meeting of the British Association for the Advancement of Science, Hull, September 1922. Pp. 15+9+24+30+15+12+27+17+14+15+14+11+15+34. (London: John Murray, 1922.) 6*s*. net.

UNDER the title of "The Advancement of Science," the British Association now issues in collected form, and as a separate volume of a convenient size, even before the conclusion of the annual meeting, all the addresses, presidential and sectional, which have been delivered at that meeting. Although, perhaps, some exception might be taken to the appropriateness of the main title, as not sufficiently indicative of the actual contents of the volume, any ambiguity is removed by the subsidiary title, which

states explicitly of what these contents consist. This issue is, of course, in anticipation of the annual volume, which gives a complete record of the Association's proceedings at the particular meeting, but which cannot, in the nature of things, make its appearance until some time after its conclusion.

This practice of the Association, which is of comparatively recent origin, is altogether to be commended, and as a business proposition is to the credit of the management. Experience has shown that it meets a public demand. Members who attend a meeting are ready to purchase, at the comparatively low price of issue, a collected edition of the addresses, as are those who are unable to be present. The fact is significant of the increasing appreciation in which these addresses are held by the public. In the early days of the Association it was not considered obligatory on the part of a president of a section to prepare a special address by way of opening its proceedings, and he occasionally contented himself with a few general remarks before calling upon a member charged with the preparation of a report on the progress of the particular department of science with which the section concerned itself, either to read the report or to give an abstract of its contents. Failing the report he would call upon a member to present the first communication on the list, and in some such manner the business of the section would be begun. Gradually the present custom has been evolved, and the presidential addresses have become a valuable and most important feature of the work of the section—some people, indeed, would say the most valuable and important.

The presidents of sections nowadays are invariably representative men or women—recognised authorities on the special subjects with which the section deals. They are usually active workers in the development of knowledge on these subjects—persons with experience of research and of matured judgment, with a message of advice, counsel, or warning to communicate, or they may even promulgate a wholly new departure in scientific thought. Hence the eagerness and expectancy with which these utterances are awaited, not only by the professional members of the section but also by such portion of the general public as shows its interest in the progress of science either by attending the meetings of the Association, or following its proceedings in the press. The appreciation in which these sectional addresses are now held is further shown by the measures which the executive have been required to take in deference to public demand. Formerly the addresses were all given on the same day, and as a rule at the same hour, and they initiated the work of their respective sections. Nowadays special arrangements are made, so that members may have an opportunity of hearing as many as possible during the week over which the meeting extends. Their publication in collected form during the week of the meeting will be of service to those who for various reasons are unable to take advantage of such opportunity, and will be welcomed by others who may wish to study them in detail and at leisure. There are, of course, some, and they are particularly common among those of the student habit, upon whom the printed word makes a more effective impression than that spoken.

It is unnecessary on the present occasion to say anything at length concerning the contents of the volume before us. Any detailed examination or criticism is the more uncalled for, as most of the addresses themselves, slightly abridged in some cases, have been, or are being, reproduced in these columns. It is sufficient to say that the 1922 book worthily sustains the reputation which British Association addresses now enjoy, as well-written, scholarly productions, pregnant with thought, replete with fact and suggestion, stimulating and full of interest and inspiration to the contemplative kind. In an age which is pre-eminently scientific these books deserve the widest possible circulation, and in the interests of knowledge it is to be hoped that they will attain it.

Our Bookshelf.

Der fossile Mensch: Grundzüge einer Paläanthropologie. Von Prof. Dr. E. Werth. Erster Teil. Pp. iv + 336. (Berlin: Gebrüder Borntraeger, 1921.) 20s.

ENGLISH students who wish to know what their German colleagues think of recent discoveries of fossil man will be somewhat disappointed when they consult this work. Its author, Prof. Werth, who has published several books on the Ice-age and allied geological subjects, has either never heard of the fossil remains discovered at Piltdown and fully described by Dr. Smith Woodward, or refuses to believe in their authenticity; at least no mention is made of them. Nor is any allusion made to the remains found at Boskop, South Africa, the fossil skull found at Talgai, Queensland, nor those found by Prof. Eugene Dubois at Wadjak-Java. On the other hand, full and welcome accounts are given of two important finds made in Germany during war-time. One of these was made at Ehringsdorf, near Weimar, where two fossil lower jaws were found. These are attributed —and rightly so—to Neanderthal man, whose distribution is thus carried beyond the watershed of the Rhine. The other discovery, which was made at Obercassel, near Bonn, has revealed the remains of a man and of a woman belonging to the last phase of the Ice-age, and regarded by their discoverers as members of the so-called Cromagnon race. The skull of the man serves very well as the prototype of many a specimen found in neolithic graves in Scandinavia and Britain, but has such outstanding cheek-bones, zygomatic arches and angles of the jaw (or jowls) as have never been seen in

European skulls hitherto. The width of the face in front of the ears is 153 mm., at the angles of the lower jaw 127 mm., betokening an extraordinary development of the masseter muscles. Notwithstanding these features, the skull is that of a strong, handsome, and big-headed man.

The opening chapters of this work are devoted to an orthodox and clearly worded description of Europe in the Ice-age. In dealing with human remains, Prof. Werth depends very largely on the methods and conclusions of Schwalbe and of Klaatsch. Prof. Werth accepts Schwalbe's verdict that Neanderthal man was not the precursor of modern man, but was extinguished by the arrival of the Aurignacian race in Europe. He is inclined to think the Cromagnon type represents a later invader of Europe, and accepts this type as the precursor of the long-headed modern Europeans—both of the dark Mediterranean and of the fair Scandinavian type. The work, of which this is Part 1, is well illustrated.

Studien an Infusorien über Flimmerbewegung, Lokomotion und Reizbeantwortung. Von Dr. Friedrich Alverdes. (Arbeiten aus dem Gebeit der experimentellen Biologie, Heft 3.) Pp. iv+130. (Berlin: Gebrüder Borntraeger, 1922.) 12*s*.

THE little book under notice is a record of careful work, chiefly upon the behaviour of *Paramœcium caudatum*, although the three other species of Paramœcium, *Stentor polymorphus*, and other Infusoria, figure in some of the experiments. The author has made an especially detailed study of the movements of Paramœcium and of the action of its cilia, and his observations on its morphology are not without interest. He discusses the behaviour of these organisms when operated upon, and also their reactions to narcotics and other chemical stimuli and to the galvanic current.

While the author admits the merit of Jennings's work in this field of study, he is, nevertheless, frequently in conflict with this worker, both in his observations of behaviour and his interpretations of them; but it is not certain that he thoroughly grasps Jennings's views, and it is noteworthy that the latest edition of "The Behaviour of the Lower Organisms" (Columbia Univ. Press, 1915) is not in Dr. Alverdes's Bibliography. Dr. Alverdes ranges himself energetically against all those who see in the Infusoria nothing but "small automata," and vigorously opposes the mechanistic interpretation of their behaviour. Like Jennings, he denies that the local action theory of tropisms can explain completely the behaviour of these organisms. He would substitute for it another view to which his researches have led him, but it is impossible, in the short space at our disposal, adequately to present this view or to criticise it. Undoubtedly Dr. Alverdes's work is careful, and is marked throughout by independence of mind. He insists, with admirable emphasis, that little progress can come from the study of the Protista in unusual media or in media which are artificially prepared upon physico-chemical principles alone. The same argument might be applied with profit to all other work on the Protista.

In spite of a rather difficult and discursive style, the book should not be neglected by those who are interested in the problems with which it deals.

An Introduction to Electrodynamics: From the Standpoint of the Electron Theory. By Prof. Leigh Page. Pp. vi+134. (Boston and London: Ginn and Co., 1922.) 10*s*. net.

HITHERTO the mathematical equations of electrodynamics have been based on the experimental conclusions of Coulomb, Ampère, and Faraday. Even books which discuss relativity go no further than showing that these equations are co-variant for the Lorentz-Einstein transformation. In Prof. Page's book, however, the equations are derived directly from the principle of relativity. The mathematician will appreciate this procedure as it is more logical, but we think that the average reader will find the older methods more convincing. The units chosen are those advocated by Heaviside and Lorentz. The value of the charge at any point is equal to the number of tubes of force diverging from the point; all matter is assumed to be made up of positive and negative electrons; electromagnetic force is defined in terms of the electric intensity of lines of force, and gravitational attraction between two electrons is supposed to be negligibly small. The electrons carrying a current are all of the same sign, and their masses are positive. Hence the "mass of the current" is greater than the sum of the masses of the individual electrons composing it.

The author's methods of calculating the radiation from electrons are to be commended, and he also gives a good account of Laue's theory of the diffraction of X-rays. The formulæ deduced for specific inductive capacity, magnetic permeability, and metallic conductivity agree fairly well with experimental results. The theories of Faraday's experiment showing the rotation of the plane of polarisation of light by a magnetic field and of the Zeeman effect are given briefly, but in a convincing way. We can commend this book to the electrician who has an advanced knowledge of mathematics and is interested in the latest theories.

Handbuch der biologischen Arbeitsmethoden. Herausgegeben von Prof. Dr. E. Abderhalden. Lieferung 55. Abt. V: *Methoden zum Studium der Funktionen der einzelnen Organe des tierischen Organismus.* Teil 6, Heft 3. *Sinnesorgane: Lichtsinn und Auge.* Pp. 365-462. (Berlin und Wien: Urban und Schwarzenberg, 1922.) 117 marks.

THIS portion of the work, Abderhalden's "Handbuch," is the direct continuation of parts 3 and 41 which dealt with the biophysical methods used in investigating the living eye and its sensitivity to light. The first section, by Dr. Vogt of Basel, is devoted to the method of examining the eye with light from which the red rays have been absorbed by passage through a concentrated solution of copper sulphate and a weak solution of erioviridine. With such light, investigations of the yellow spot are rendered much easier and more accurate. The second section of 76 pages, by Dr. Basler of Tübingen, deals with methods which in the main are intended to investigate the functions of the retina and its various parts. Sharpness of vision, irradiation, and detection of movement are some of the subjects dealt with. The concluding section, by Dr. Struycken of Breda, describes the photographic method he uses for studying the

movement of the eyeball from side to side. The treatment is in general more wordy than is desirable, but the work brings together in an accessible form a large amount of information hitherto buried in memoirs, published in most cases abroad.

Our Homeland Prehistoric Antiquities, and How to Study Them. By W. G. Clarke. (The Homeland Pocket Books, No. 13.) Pp. 139 + plates. (London: The Homeland Association, Ltd., 37-38 Maiden Lane, 1922.) 4*s*. 6*d*. net.

MR. CLARKE'S little handbook on the prehistoric antiquities of Britain covers the whole subject from Eoliths to the Iron Age. One of its main objects, however, is to help the novice to discriminate between stones shaped by natural forces and those chipped by man. In so far as this is possible by means of the printed word, Mr. Clarke is a good guide, while his practical hints on where and how to look for implements will be of great assistance to those taking up field work for the first time. As it covers so wide a field the treatment is necessarily summary, while in dealing with controversial points conclusions are stated dogmatically, which, in a more ambitious work, would require extended discussion. For this reason, Mr. Clarke must be forgiven some over-hasty statements. The amount of information which he has succeeded in condensing into so small a compass is remarkable. There are few subjects connected with prehistoric peoples of these islands, whether it be their implements, their dwellings, or their modes of life, about which the beginner will not find sufficient information here to open a path to further study, and this, in a book of this type, is in itself a great achievement.

Homo (Os Modernos Estudos sobre a Origem do Homem.) By Prof. A. A. Mendes Corrêa. Pp. 318. (Lisboa; Porto; Coimbra: Lumen Empresa Internacional Editora, 1921.) n.p.

IN this country the work of Portuguese anthropologists is not too widely known; yet it is deserving of more attention than it receives. In prehistoric archæology and somatology, investigations are being carried on which, if not considerable in bulk, are of some importance for students of European ethnology. We therefore welcome the opportunity of directing attention to this book by Prof. Mendes Corrêa, in which the most recent discoveries and hypotheses relating to the origin and descent of man are critically discussed. Each chapter deals with some one aspect of the problem, beginning with "the animal origin of man," and passing on to "evolution," the evidence of palæontology, *Pithecanthropus erectus*, the skeletal remains of prehistoric man, anthropogenesis, and a detailed exposition of the neo-monogenistic point of view. It is interesting to note that the author, in the case of the Trinil and Piltdown remains, adheres to the view in the former that the fragment of skull is simian and the femur human, and in the latter that the cranium is human and the jaw simian. A final chapter summarises the author's views, published elsewhere, on the influence of environment in the formation of races, and reviews the problems which await elucidation by further discoveries.

Sound: An Elementary Text-book for Schools and Colleges. By Dr. J. W. Capstick. (Cambridge Physical Series.) Second edition. Pp. viii + 303. (Cambridge: At the University Press, 1922.) 7*s*. 6*d*.

IN the second edition of Dr. Capstick's text-book of sound, a chapter has been added giving an outline of some of the more important applications of acoustics to military operations during the war of 1914–18. The author is not very successful in conveying in the fewest possible words a clear idea of the apparatus employed, and his descriptions would have been improved by the use of diagrams. It must, however, be pointed out that some of the diagrams in the earlier chapters are by no means perfect. In Fig. 95 the pendulum would quickly damage the mercury cup, and it is doubtful whether the Bell telephone in Fig. 99 would have been recognised by its inventor. The granular transmitter, inadequately illustrated on page 222, does not serve in this primitive form as a suitable microphone for use in a hydrophone. The author has obviously made a slip when he says that in signalling under water the sound is received by a submerged microphone similar to a *receiving* telephone. In spite of some defects the volume will serve a useful purpose as a class-book for schools.

Sewerage and Sewage Disposal: A Textbook. By L. Metcalf and H. P. Eddy. Pp. xiv + 598. (New York and London: McGraw-Hill Book Co., Inc., 1922.) 25*s*. net.

THE volume before us is the work of the authors of a three-volume treatise on "American Sewerage Practice," and is the result of a demand for a shorter book suitable for students who have not a great deal of time to devote to this subject. The early sections of the book deal with the main outlines of the problem of sewerage—the quantity of sewage to be expected, storm water, hydraulics, etc. Methods of surveying and excavating are then treated, together with the details of carrying out the work. The later sections deal with the chemical and biological characteristics of sewage and with disposal methods. There is a chapter on cost-estimating at the end of the volume. The authors are engineers whose practice brings them into intimate contact with the matters treated; this is reflected in their book, which cannot fail to be of service to students, British as well as American. The volume is profusely illustrated and is thoroughly up-to-date. There are some useful graphs, among which we note one giving the discharge of egg-shaped sewers running full depth, which is based on Kutter's formula.

Manuel de tournage du bois. Par Hippolyte Gaschet. (Bibliothèque Professionnelle.) Pp. 248. (Paris: J.-B. Baillière et Fils, 1922.) 10 francs net.

A VERY good account of the tools used and the methods employed in wood-turning is given in this little volume, which will be found to be supplementary, in some respects, to English works on the same subject. The language difficulty will probably prevent the book from reaching the hands of many young workers in this country, but manual instructors should find it useful, especially in view of the graduated series of exercises which is included at the end of the volume.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Periodicities.

THE recent paper by Sir William Beveridge on "Wheat Prices and Rainfall" (Journal of the Royal Statistical Society, vol. 85, pp. 412-478, 1922) raises a rather important question of principle which is involved not only in discussions over the existence of periodicities, but also over relationships between different variables.

Before Schuster's papers on the periodogram it was customary for a period to be accepted as real provided that it had an amplitude comparable with that of the original figures under analysis; and he revolutionised the treatment of the subject by showing that if the squares of the intensities of the various periodic terms are plotted in a periodogram, and if the data are those of an entirely chance distribution, then the average value of an ordinate being a, the probability that a particular ordinate will equal or exceed ka is e^{-k}. Sir William Beveridge is accordingly perfectly justified in taking Schuster's sunspot period of 11·125 years, or Brückner's 34·8 year period, and deciding that these periods probably occur in his wheat prices if the corresponding intensities are three or four times the average. But he, like many other investigators, goes a stage further, and after picking out the largest from a large number of intensities he applies the same criterion as if no selection had occurred. It is, however, clear that if we have a hundred intensities the average of which, a, is derived from a number of random figures, then the probable value of the largest of these chance intensities will not be a but will be considerably greater, and it is only when the largest amplitude actually derived materially exceeds the theoretical chance value thus obtained that reality can be inferred.

Taking the periodicities of wheat prices on pp. 457-459 between 5 years and 40 years,[1] I estimate that the "width of a line" ranges from 0·1 year for a 5 years' period, through 0·5 at 12 years to 4 years at 33 years; and accordingly that the number of independent periods between 5 years and 40 is in this case about 51. The value of a, the average intensity, being 5·898, it is easily seen that the chance of all the 51 random intensities being less than $3a$ is $(1-e^{-3})^{51}$, or 0·074, so that the chance of at least one intensity greater than $3a$ is 0·926, not e^{-3} or 0·050, as is habitually assumed. Instead of the chance of an occurrence of $3a$ "making a *prima facie* case for enquiry" (p. 424), the odds are 12 to 1 in favour of its production by mere chance. The chance of at least two intensities above $3a$ is 0·728, of three it is 0·470, of four 0·248, of five 0·109, of six 0·0403, of seven 0·0127, of nine 0·00085, and of eleven 0·00003.

Thus it is not until six intensities over $3a$ are found that the chance of production by pure luck is less than 1 in 20. It is also easily found that if the chance of all the 51 intensities being less than na is to be 19/20, n is 6·9; *i.e.* the greatest intensity for wheat price fluctuations must be 41, not 18, before the probability of its being due to luck is reduced to 1/20; and if the likelihood is to be 1/100 we must have $n = 8·5$, the corresponding wheat-price intensity being 50. Of intensities greater than 41 Sir William Beveridge found four, and greater than 50 only two.

[1] Sir William Beveridge points out on pp. 423-424 that amplitudes for periods of less than 5 years are inevitably diminished, while those above 31 are diminished by the process employed for eliminating secular trend: I calculate that the intensity at 35 years should be multiplied by $(0·87)^{-2}$ or 1·3, and that at 54 by 3·8.

At first sight it might seem that the agreement between Sir William Beveridge's forecasted synthesis rainfall curve and the actual rainfall was too great to be explained by a few harmonic terms; but the correlation co-efficient of 0·38 (see p. 475) indicates that while 0·38 of the rainfall variations are accounted for, only $(0·38)^2$, or about a seventh, of the independent factors which control these variations have been ascertained.

As pointed out in a paper "On the Criterion for the Reality of Relationships or Periodicities," in the Indian Meteorological Memoirs (vol. 21, No. 9, 1914), the same principle is valid when discussing relationships. If we are examining the effect of rainfall on temperature and ascertain that the correlation co-efficient between the rainfall and temperature of the same month in a particular English county is four times the probable error, we may infer that the effect is highly probable. But if we work out the co-efficients of that temperature with a hundred factors taken at random, *e.g.* with the monthly rainfall of Tashkend 5·8 years previously, and pick out the largest co-efficient, it would be wrong to compare it with the average co-efficient produced by mere chance; as shown in the paper referred to, the probable value of the largest of 100 co-efficients is 4·01 times as great as the probable value of one taken at random.

GILBERT T. WALKER.

Meteorological Office, Simla, August 24.

DR. WALKER'S note contains, I think, a valid and valuable criticism of the procedure commonly adopted hitherto in comparing individual intensities with the average intensity in harmonic analysis. It would lead me now to modify in several ways my general discussion of the "test of intensity" (pp. 422-424 of my paper in the Journal of the Royal Statistical Society. I was particularly careful, however, in that paper to avoid laying stress on intensity as such. The net result of Dr. Walker's calculations is not to weaken but to confirm my main thesis: that a number of real periodicities exist in European wheat prices from 1550 to 1850.

According to these calculations, the chance of my getting by pure luck between five and forty years one intensity as great as $3a$ is 0·926, but the chance of my getting seven such intensities is 0·0127, and that of getting eleven is 0·00003. Actually I have, between five and forty years, fifteen intensities above $3a$ (=17·69); the odds are therefore 80 to 1 that at least nine of these intensities, and 33,000 to 1 that at least five of them, are not due to luck. Obviously every such intensity does, in the circumstances, present a *prima facie* case for further inquiry, the object of the inquiry being to determine which of the 15 intensities have the strongest probabilities of being due to real periods.

In that inquiry the actual height of the intensity in any case (the "test of intensity") is only one and not necessarily the most important point for consideration. As Dr. Walker shows, an intensity in my periodogram of nearly seven times the average might well be due to pure luck (the odds being only 20 to 1 against it). On the other hand, a much lower intensity might represent a true and perfectly regular but weak periodicity, just as a quite small correlation co-efficient may prove a real though weak connexion, if the number of cases compared is very large. Indication of the same period in each half of a sequence when analysed separately (the "test of

continuity") and in independent sequences (the "test of agreement with other records") are often more important criteria of reality than is the height of the intensity itself. The former test, at least, should never be neglected; it has led me to relegate to my fourth class as merely "possible," several periods, such as those near 11, 17, and 24 years, indicated by high intensities in the whole sequence, but failing in either the first or the second half.

Ultimately, of my fifteen intensities between 5 and 40 years, I have treated only nine (at 5·100, 5·671, 5·960, 8·050, 9·750, 12·840, 15·225, 19·900, and 35·500 years respectively) as certainly or probably due to real periodicities, because they show in all cases perfect or fair continuity and in most an agreement with other records. The smallest of these fifteen intensities (21·72 at 7·417 years) in fact equals not $3a$ but $3{\cdot}683a$. If with this revised figure, the probabilities are calculated in the way suggested by Dr. Walker, the odds that at least nine of the fifteen intensities are not due to luck work out at more than 2000 to 1, while the odds in favour of seven at least are 14,000 to 1.

This remarkable result, which seems to establish beyond all reasonable doubt the reign of periodicities in wheat prices, is not affected by the fact that of the fifteen intensities only four are so high that any one of the four, if it occurred alone and had to be judged by height alone, would have odds of more than 20 to 1 in its favour. Each intensity does not occur alone. Every period, moreover, to which I attach importance rests on more evidence than mere height in my periodogram.

With reference to the last paragraph but one of Dr. Walker's note, on the relation of my synthetic curve and the rainfall, I should like to emphasise the point made in my paper (pp. 449-450) that the synthetic curve as now drawn represents only a first approximation of the roughest possible character; the correlation co-efficient of 0·38 between it and the rainfall from 1850 to 1921 is sufficient to demonstrate some connexion between the wheat price cycles and the rainfall, but is in no sense to be treated as a measure of the degree of connexion. In constructing the synthetic curve, for instance, the periodicities have all been treated as of equal importance; inspection shows that weighting according to the intensities would almost certainly give a better fit and so a higher co-efficient of correlation. In many other ways a more accurate determination of the cycles is required. How high a correlation might ultimately be obtained as the result of this, it is impossible now to say, but it might easily prove to be very high indeed. Unfortunately, I have no resources for carrying my own investigations further for the present; I can only hope that others may be better placed.

W. H. BEVERIDGE.

One Possible Cause for Atmospheric Electric Phenomena.—A Query.

MAY I ask Sir Arthur Schuster or Dr. Chree or some other authority whether there is any serious objection to an idea like the following:

The sun being radio-active emits not only gamma rays, which ionise the atmosphere, but also alpha and beta particles. The alpha particles will be stopped by the upper layers of atmosphere, charging them positively, while the beta particles will be more penetrating, and might even reach the ground, charging it negatively; though I admit that thirty inches of mercury is a serious obstruction. But, as Arrhenius showed, the beta particles would be magnetically inveigled towards the poles, where they might descend with down currents: whereas the alpha particles—most numerous near the tropics—would be sustained by up currents; and thereafter the separated charges would reunite with familiar dielectric disruption.

OLIVER LODGE.

Normanton, Lake, Salisbury, Sept. 29.

School Instruction in Botany.

IN the article on "School Instruction in Botany" in NATURE of September 2, p. 329, the report on the botany gardens of the James Allen's Girls' School, recently published by the Board of Education, was reviewed. As I am not only the author of the report but also the initiator and organiser of the botany gardens at Dulwich, I shall be glad if space can be afforded me to reply to the following comment at the end of the article: "No mention is made in the Report of the utilisation of the botany gardens for the observation of animal life." The omission is due to the fact that the report was written in 1915 (see prefatory note) when some of the "gardens," which are now of great help in studying animal life, were in an undeveloped condition.

For example, in 1915 the oak trees in the new wood were only from three to four years old and looked somewhat like sticks, as shown in Plate 10. Since 1915 the trees have grown so much that blackbirds, hedge sparrows, and a thrush have built nests, laid their eggs and in all cases but one reared their young in our wood. Advantage of this has been taken and many girls have visited the nests. During outdoor lessons, girls have learned to recognise birds which frequent the school garden, and have become familiar with their calls and songs.

In the spring term the awakening of the numerous frogs which hibernate in the school pond is eagerly awaited. For a short period the pond is densely populated by hundreds of croaking frogs. Later, the development of the tadpoles through all the stages is watched with the keenest interest by girls of all ages. Observation of animal life in the pond includes the study of the life-histories of china mark moths, dragon flies, newts, great water beetles, water boatmen, and water snails. On one occasion last term many girls watched the various stages in the emergence of a china mark moth from its chrysalis.

In these and in other ways the botany gardens at the James Allen's Girls' School are utilised for the observation of animal life.

LILIAN J. CLARKE.

James Allen's Girls' School,
East Dulwich Grove, S.E.22, September 28.

Transcription of Russian Names.

IN his further letter (NATURE, July 15, p. 78) Lord Gleichen refers to the Royal Geographical Society's System (II.) for the transcription of foreign alphabets into English. A copy of this system has just reached us and impresses us with its completeness and utility, especially for rendering place-names into English.

With regard to the transcription of Russian names we agree with Lord Gleichen that French, German, and hybrid transcriptions are unsatisfactory, but we would advocate, with Prof. Brauner, an international system, and for this purpose the Czech transcriptions have much to recommend them.

In the first place, the Serbian alphabet contains fewer letters than the Russian, and is thus inadequate to allow of accurate transcription from Russian by

the Serbo-Croatian rules. Czech transcription has the advantage of being complete.

The following examples may serve to make this clear. Russian а has only one sound, as in "master." It has the same sound in Czech, but the English *a* has several sounds. If ж is rendered by *j* it is liable to mispronunciation; if transcribed to the Czech ž this liability does not arise. Russian у is always pronounced like the Czech *u* (like *oo* in the English word "hook"). Russian х can be correctly rendered by the Czech *ch*.

"Hard mute" and "soft mute" (ъ and ь) can only be transcribed into Czech, using the hook ˇ after the consonant. Russian ы has no other European sound except the Czech *y*. The different pronunciation of the Russian е, ѣ, э cannot be easily expressed in English, but this becomes easy by using the Czech ě for the first two, especially the second.

It may be pointed out that the Czech transcription is already employed in the International Catalogue of Scientific Literature, and for some years German journals (*e.g. Zeitschr. f. anorg. Chem.*) have employed letters with diacritical marks in their transcription of Russian names (*e.g.* "Žemczuznyj," which in Czech is "Žemčužný").

The objection, urged by Lord Gleichen, to the use of diacritical marks exists, but is relatively small. Most scientific journals already have such type, which is indeed necessary if Czech names are to be printed correctly. Newspapers naturally lag behind such a journal as NATURE in matters of this kind, but in time these too will doubtless find it necessary to have letters with diacritical marks in their founts.

Lord Gleichen also asks how many English people can correctly pronounce Czech letters like č. It is regrettable, but nevertheless true, that the correct pronunciation of foreign words is not a great characteristic of the British people, but it is as easy to learn how to pronounce Czech words as it is those of other languages. The example which was chosen by Lord Gleichen is poor, because the sound "č" exactly corresponds to the English sound "ch" (*e.g.* "church").

J. G. F. DRUCE.

Bled, Carniola, Jougo-Slavia.

A. GLAZUNOV
(formerly docent at
Petrograd Polytechnic).

Prague, Král. Vinohrady, Wenzigova 21,
Czecho-Slovakia,
August 5.

Colour Vision and Syntony.

IN NATURE of September 9, p. 357, Prof. E. H. Barton has shown how a syntonic hypothesis of colour vision may be made to represent the trichromatic theory of colour vision. There are numerous facts which are quite inconsistent with any form of the trichromatic theory. These are given in detail in my recent book on the "Physiology of Vision" and subsequent papers, and no attempt has been made to answer any one of them. Every fact points to the visual purple being the visual substance which, sensitising the liquid surrounding the cones, sets up a visual impulse in the cones when decomposed by light. Houstoun's explanation of the physical processes is in complete accordance with the facts, and so far as I am aware no valid objection to it has been found.

Any theory of vision must explain the movement of the positive after-image in the retina. For example, if the positive after-image of a small white triangle on black velvet be obtained with one eye, on moving the head with a jerk, both eyes being covered, an irregular white figure will be seen some little distance away from the clearly cut black triangle, the negative after-image in the original position which is seen when a small amount of light is allowed to enter the eye through the lids. Another very simple method of seeing this movement of the positive after-image is to look at three windows on awaking, which are separated by walls; on closing and covering the eyes, well defined positive after-images of the windows separated by black spaces corresponding to the walls are seen. On covering the eyes and moving the head from side to side the after-images all blend into one, the black spaces being obliterated.

Let us compare the model given by Prof. Barton with the known facts of vision. For any particular light the three vibrators acting together should give the luminosity curve for that light. Barton has placed the red vibrator at about $\lambda 760\ \mu\mu$; here the red has very little luminosity, whereas a driver of the length of the vibrator at this point will produce most effect. Again, drivers corresponding to the infra-red or ultra-violet will affect the red or violet vibrators respectively, whereas these regions are invisible.

When we come to colour blindness the trichromatic theory fails completely. How on this theory can the fact that more than fifty per cent. of dangerously colour blind people can pass the wool test be explained? The fact that a dichromic may have a luminosity curve similar to the normal, that the trichromic have only three colour sensations and designate the yellow region as red-green, and the other degrees of colour and light perception, has to be explained.

F. W. EDRIDGE-GREEN.

London, September 19.

The Green Ray at Sunset and Sunrise.

THE review by Sir Arthur Schuster of Mulder's book on the green ray or green flash at rising and setting of the sun, in NATURE of September 16, p. 370, leads me to make the following remarks:

There are, in reality, two distinct phenomena which go under the name of the green flash. The first, probably the one most usually seen and the only one to which the epithet properly applies, is certainly an after-image in an eye fatigued by the red light of the sun. I have seen it many times, only at sunset, and in many localities—on the Red Sea (twice in one evening owing to the sun being occluded by a narrow bank of cloud prior to its actual setting), in Devonshire, and even in London as the sun set behind University College Hospital.

This phenomenon can be reproduced quite easily in the laboratory by means of an artificial red sun, as I demonstrated a few years ago at a meeting of the Physical Society of London.

The second phenomenon, which I have never been successful in seeing and of which I can say little, is evidently due to atmospheric dispersion; and, from the published accounts, I should judge that it should be called the blue sun or multicoloured sun or spectrum flash. It would seem to be much more rare, as I gather from Sir Arthur Schuster's previously made descriptions that it requires rather special conditions.

If this subject should get into elementary text-books, as recommended, at least let the account of it be complete.

ALFRED W. PORTER.

University College,
London.

Photography of Bullets in Flight.

By PHILIP P. QUAYLE, Assistant Physicist, National Bureau of Standards, U.S.A.

INSTANTANEOUS photography by means of an electric spark provides the investigator of high-speed phenomena with a most valuable source of data. Such photographs are of the shadow variety, the bullet shadow being projected upon a photographic plate by a spark of great intensity and short duration. If the bullet is moving with a speed equal to or greater than that of sound, it propagates from both its nose and base

FIG. 1.—Automatic pistol in position of extreme recoil, empty cartridge case not yet ejected.
T=trigger; R=receiver; A=arm operating trigger.

a compressional wave. Light from the photographing spark in passing through the denser atmosphere of the compressional wave is refracted as by a lens, so that the wave front is also projected upon the photographic plate with the bullet. The method lends itself readily to the investigation of a projectile's stability at various points along its trajectory and to many allied problems of exterior ballistics. Instructive photographs of the recoil and shell ejection of automatic rifles, pistols, and machine guns may also be obtained in this manner.

Among the most important of the early contributions in this field of research are the admirable spark photographs by Prof. C. V. Boys (NATURE, Vol. 47, pp. 415 and 440), who greatly simplified the elaborate apparatus of Prof. E. Mach. In Prof. Boys's apparatus the bullet was employed to close the spark circuit, and this method has been followed in experiments which have been carried on since that time, so far as the present writer is aware.

In the method described in this article the setting-off or triggering of the electric spark by which the photographs are taken is controlled by the compressional wave produced by the flight of the bullet, so that no wires or other portions of the apparatus need appear on the plates. Since the sound wave is used to trigger the photographing spark, the position of the rifle firing the bullet may be varied at will without affecting the functioning of the apparatus, the only requirement being that the bullet shall have a speed greater than that of sound. When the speed of the bullet is less than that of sound the muzzle blast may be used to trigger the spark. In such cases the rifle must not be moved.

In Prof. Boys's type of apparatus the photographing spark is set off by the closing of a secondary gap by the bullet itself. In the present apparatus a much more powerful spark may be used than would otherwise be possible, because the potential available for the photographing spark is not limited by the dielectric strength of some trigger gap of fixed and small dimensions.

The regulation of the potential of the spark is essential, however, since great irregularities in time occur when the apparatus is not operated at the same potential, the spark occurring earlier or later than the transit of the bullet across the plate. This, of course, precludes satisfactory records when working with modern high-speed bullets. When the proper potential has been attained a signal light is automatically turned on.

No lens system is employed in the apparatus. An arrangement which has been found very satisfactory places all of the photographic apparatus, except the trigger, inside a small light-tight house.

The trigger itself is located outside the house and near the trajectory. This trigger is an interrupter of the type used by the French in connexion with the Joly chronograph. The use of this instrument and the type of springs used in the photographing-spark-switch were suggested by Dr. D. C. Miller, of the Case School of Applied Science, where the apparatus was developed. The trigger consists of a metal diaphragm about 2 inches in diameter enclosed in a circular metal box. The diaphragm forms one side of an air-tight enclosure, and on the inside face of the diaphragm is attached a circuit-breaking mechanism. This circuit-breaker functions when the crack wave emanating from the bullet strikes the diaphragm, which in turn throws back a small hammer, thus interrupting the circuit and

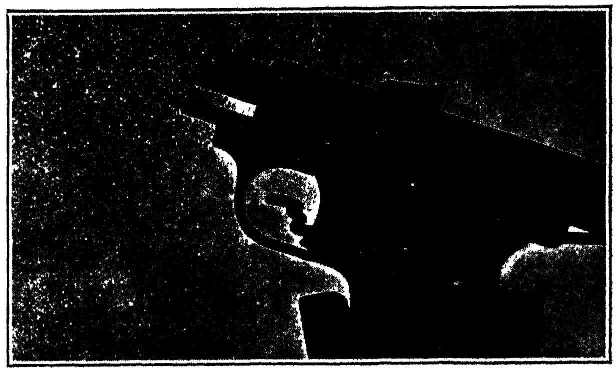

FIG. 2.—Automatic pistol; empty cartridge case just emerging from the receiver.

tripping the photographing-spark-switch, with which it is connected in series.

The essential parts of the photographic apparatus consist of a large Leyden jar battery charged by a static machine which is motor driven, the control switch for the motor being mounted on the table with the rifle. A potential regulator which is connected across the battery functions when the proper potential has been reached, and trips a switch which disconnects the battery from the charging machine and short-circuits the terminals of the latter. The switch when tripped turns on a signal light located outside the apparatus house as a signal to the rifle operator to fire.

When operating the apparatus the general sequence of events is as follows:

The photographing-spark-switch and battery-switch inside the apparatus house are set, the lights turned out, and the slide of the plateholder drawn. The operator then leaves the apparatus house by means of a light-tight passage and starts the static-machine motor by closing the table switch. He then makes any necessary correction to the aiming and fires when the signal light appears. The bullet leaves the rifle and on its way to the apparatus house passes the trigger upon the diaphragm of which the sound wave impinges. This immediately trips the photographing-spark-switch and it starts to close the trigger gap in the spark circuit. The bullet continues on past the trigger, entering the apparatus house through a sheet of thin paper, used to shut out the light, and arrives in front of the photographic plate, upon which it is then projected by the photographing spark. The motor switch is then opened and the slide replaced in the plateholder, which may then be taken to the dark room and developed.

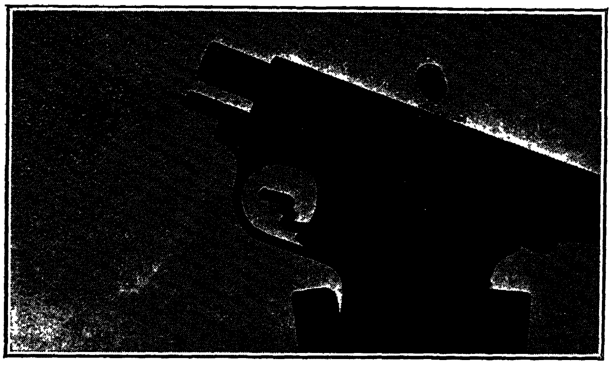

FIG. 3.—Automatic pistol; empty cartridge case ejected from receiver.

In case the speed of the bullets to be photographed is not known, a piece of paper or wire screen is placed in the path of the bullet in front of the photographic plate, and if a puncture in the screen is shown when the plate is developed, evidently the bullet had gone past the plate before the spark occurred. The trigger must then be moved back from the plate and the process repeated. Continuing in this manner the position of the bullet when the spark occurs will soon be bracketed within limits sufficiently small, so that an observer inside the apparatus house may see the bullet as the spark illuminates it. Visual adjustment only is then used until most of the bullets are seen in the desired locality when the spark occurs.

The apparatus is provided with two light gaps, one horizontal and the other vertical. This arrangement facilitates the taking of two photographs of the same bullet, a plan and elevation view. This is particularly useful in investigating a projectile of an unstable character having a tendency to tumble, since from the two views its actual position in space may be constructed.

The two coaxial waves which the bullet propagates from its nose and base appear on the photograph (Fig. 4) to have different slopes. This arises from the projection, for while the axis of the wave is parallel to the photographic plate, and therefore projected in proportion to its length, the radius of the projected wave is somewhat inclined to the plate and causes the distortion. The true angle of the conical sound wave in air may, however, be readily computed, from which the speed of the bullet producing the wave may be determined.[1]

In obtaining the photographs of the Colt automatic 25-calibre pistol, reproduced in Figs. 1, 2, and 3, the interrupter trigger was removed from the circuit and a timing device substituted, which consists of two electromagnets connected in series and adjustable in height, their function being to drop two steel balls at the same time when the key opening their circuit was depressed. One of these balls fell on a lever which pulled the trigger T of the automatic pistol by exerting tension on the arm A (see Fig. 1). The other ball, released from a greater height at the same time as the first, impinged on a device setting off the photographing spark. By this means any reasonable lag or lead in the firing of the pistol with respect to the occurrence of the photographing spark could be obtained. The firing apparatus is obviously not a precision instrument and could, of course, be replaced by an accurate timing device should the investigator require information of such a character.

The turbulent gases of the propelling charge are clearly shown in Figs. 1, 2, and 3. All these photographs of the automatic pistol represent a stage in the recoil relatively long after the ejection of the bullet from the muzzle, since it will be seen that the receiver R has reached the position of extreme recoil and the empty cartridge case is being ejected in Figs. 2 and 3.

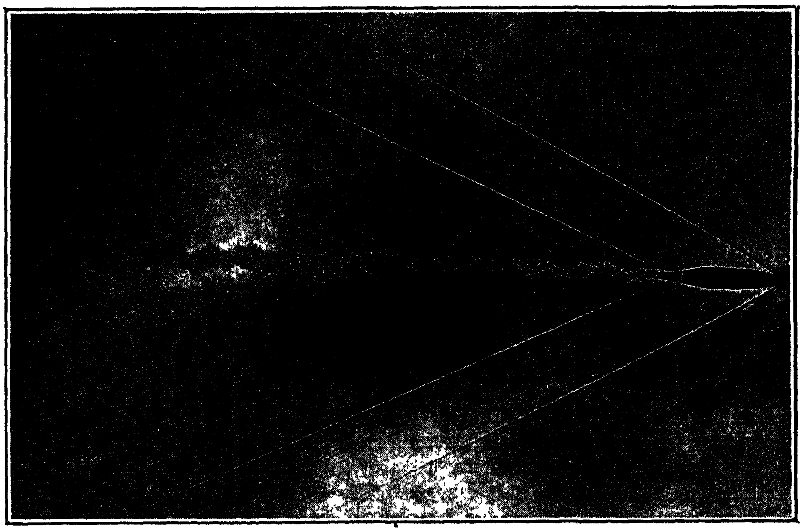

FIG. 4.—30 Calibre boat-tailed bullet, approximate speed 2600 feet per second.

If the height of the ball which triggers the spark is changed progressively by some small known amount, a series of photographs of such an automatic pistol at slightly different calculable time intervals could be secured. From the data obtainable from such photographs a pressure time curve could be computed.

[1] Journal of the Franklin Institute, May 1922.

The Study of Man.[1]

By H. J. E. PEAKE.

A CHANGE has been creeping over our science. Twelve years ago anthropologists were devoting their energies to the tracing out of the evolution of customs and material culture, assuming that, where similarities were found in different parts of the world, they were due to independent origins. It was assumed that the workings of the human mind were everywhere similar, and that, given similar conditions, similar customs would originate. The evolution of civilisation was looked upon as a single line of advance, conditioned by the unalterable nature of the human mind, and that barbarian and savage cultures were but forms of arrested development, and indicated very closely past stages of civilised communities.

But a fresh school of thought has come into prominence. According to this new view discoveries are made but once, and when resemblances are found between the cultures of different communities, even though widely separated, this is due to some connexion between them. According to the new school, the development of civilisation has been proceeding by many different paths, in response to as many types of environment, but these various advances have frequently met, and from the clash of two cultures has arisen another, often different, more complex, and usually more highly developed than either of its parents.

The old school looked upon the advance of culture as a single highway, along which different groups had been wandering at varying paces, so that, while some had traversed long distances, others had progressed but a short way. The new school, on the other hand, conceives of each group as traversing its own particular way, but that the paths frequently meet, cross, or coalesce, and that where the greatest number of paths have joined, there the pace has been quickest.

The older school, basing its views of the development of civilisation upon the doctrine of Evolution, has called itself the Evolutionary School. The newer, while believing no less in Evolution, feels it a duty to trace the various stages through which each type of civilisation has passed, rather than to assume that these stages have followed the succession observable elsewhere; thus, as historical factors form a large part of its inquiry, it has been termed the Historical School.[2]

The first note announcing the coming change was sounded from this chair eleven years ago,[3] and during the interval which has elapsed the new school has gained many adherents. All will not subscribe to the dictum that no discovery has been made twice; nevertheless there is a tendency not to assume an independent origin for any custom until it has been proved that such could not have been introduced from some other area.

These tendencies have led the anthropologist to inquire into the history of the peoples whose civilisation he is studying, and to note, too, minute points in their environment. At the same time geography began to take special note of man and his doings. This anthropogeography concerned itself with inquiring into the reactions between man and his environment, and though at first the environment was the main object of the geographer's attention, he is now inclined to pay more attention to its effect upon man. Thus anthropology and geography have been drawing closer, and as the latter is a recognised subject in our schools, no small amount of anthropological knowledge has been instilled into the minds of our boys and girls.

It might have been expected that the historians before the geographers would have been attracted to the anthropological approach, but recent events have up to now engrossed their attention. Signs have not been lacking, however, that the study of peoples and their customs, rather than of kings and politicians, is gaining ground, and we may look with confidence towards closer relations between the studies of history and anthropology.

Again, we may notice an increasing interest in our subject among sociologists and economists. These have focussed their attention upon the social organisation and economic well-being of civilised communities, with the view of presenting an orderly array of facts and principles before the political leaders. There has, however, been a tendency to trace these modern conditions back into the past, and to use for comparison examples drawn from the social organisation or economic conditions of communities living under simpler conditions. While these studies overlap those of the anthropologist, the methods used are different. We are working from the simple to the complex; they begin with highly developed conditions and thence work back to the primitive.

Lastly, we must not forget the students of the classical languages. In spite of many advantages which they possess at schools and universities, they have been losing in popularity, and the reason is not far to seek. So long as there were fresh works to be studied and imperfect texts to be emended, there was no lack of devotees to classical literature. Later, comparative philology gave fresh life to such studies, and certain views current among mid-nineteenth-century philologists gave also an impetus to the re-study of Greek mythology. But about 1890 such studies became unfashionable, and many classical scholars turned to anthropology with great advantage both to themselves and to us.

It is doubtless as a result of these converging movements that the general public is taking an interest in anthropological studies, and that works of a general nature, summing up the state of knowledge in its different branches, are in great request. The educated public wish to know more of the science of man, yet I fear they are too often perplexed by the discordant utterances of anthropologists, many of whom seem to be far from certain as to the message they have to deliver.

In their turn not a few anthropologists feel a like uncertainty as to the ultimate purpose of their studies, and are not clear as to how the results of their investigations can be of any benefit to humanity. These are points well worthy of consideration; for, as we were reminded from this chair two years ago,[4] anthropology, if it is to do its duty, must be useful to the State,

[1] From the presidential address delivered to Section H (Anthropology) of the British Association at Hull on September 7.

[2] Rivers, W. H. R., "History and Ethnology," *History*, v. 65-7, London (1920).

[3] Rivers, W. H. R., "The Ethnological Analysis of Culture," Report of Brit. Assoc., 1911, 490-2.

[4] Karl Pearson: Address to the Anthropological Section, Brit. Assoc. Report, 1920, 140-1.

or to humanity in general. Even the scope of the science is by no means clear to all, and would be differently defined by various students. It may not be out of place, therefore, to consider in detail the scope and content of anthropology, then its aims and the services it may render to mankind.

To the outside world anthropology seems to consist of the study of flint implements, skeletons, and the ways of savage men, and to many students of the subject its boundaries are scarcely more extensive. Yet civilised people also are men, and anthropology should include these within its survey. That other scientific workers, historians, geographers, sociologists, and economists, study civilised man is no reason why the anthropologist should fail to take him into account, for his point of view differs in many respects from theirs. I would suggest, therefore, that all types of men, from the most civilised to the most primitive, in all times and in all places, come within the scope of anthropology.

Anthropology is the study of man, but we need a more accurate definition. A former occupant of this chair has declared that "anthropology is the whole history of man as fired by the idea of evolution. Man in evolution—that is the subject in its full reach." He adds: "Anthropology studies man as he occurs at all known times. It studies him as he occurs in all known parts of the world. It studies him body and soul together." [5]

Anthropology may, therefore, be defined as the study of the origin and evolution of man and his works. What, then, separates anthropology from the other studies which are concerned with man is, that the anthropologist studies him from all points of view—that his is a synthetic study; above all, that evolution is his watchword; that his study is, in fact, not static but dynamic.

If, then, we grant that anthropology is the synthetic study of the evolution of man and his manifold activities, we are dealing with a subject so vast that some subdivision becomes necessary if we are to realise what the study involves. Such divisions or classification must be arbitrary, but we may consider the subject as divided primarily into two main categories: "man" and "his works."

But man himself cannot be considered from one aspect only, and it seems fitting that the anthropologist should consider that man consists of body and mind; the study of these is the special province of the anatomist, the physical anthropologist, and the psychologist. Here, again, it may be asserted that anatomy and psychology are distinct sciences, but anatomy, in so far as it helps us to understand the evolution of man, and again as it helps us to trace the variations in the human frame, is and always has been reckoned a branch of anthropology. Again, in the case of psychology, there is much which is not, strictly speaking, anthropological. On the other hand, in so far as psychology enables us to trace the development of the human mind from that of the animal, and in so far, too, as it can interpret the causes which have led to various forms of human activity, it is a branch of our science. If, too, it can help us to ascertain whether certain fundamental mental traits are normally associated with certain physical types, psychology will provide anthropologists with a means of interpreting many of the phenomena which they have noted but cannot fully explain.

The works of man are so varied that it is no easy task to classify them. We may, however, first distinguish the work of man's hands, his material culture, from his other activities. Under this heading we should include his tools, weapons, pottery, and textiles; his dwellings, tombs, and temples; his architecture and his art.

Next, we have the problems concerned with language, which we may consider as dealing with the means whereby men hold intercourse with one another. This heading might well include gesture at one end and writing at the other. Hitherto anthropologists have confined their attention too exclusively to the tongues of backward tribes, and left the speech of more advanced peoples to the philologists. I would plead, however, that language is such an essential element in human culture that comparative philologists might well consider themselves as anthropologists.

Lastly, we have social organisation and all that may be included under the terms "customs" and "institutions," a varied group, leading to the study of law and religion. Here, again, we come in contact with other studies—those of the lawyer, political economist, and theologian; but though the anthropologist is studying the same facts, his range is wider and his outlook more dynamic.

Thus it will be seen that in the three divisions of man's work, as well as in the two aspects of man himself, the anthropologist finds other workers in the field. But whereas these other sciences are concerned only with some part of man and his works, and are limited frequently to recent times and civilised communities, it is the province of the anthropologist to review them as a whole, in all times and in all places, and to trace their evolution from the simplest to the most complex.

If we accept the views of the historical school, anthropology becomes a new method of treating historical material. It is, in fact, the history of man and his civilisation, drawn not so much from written documents as from actual remains, whether of material objects or of customs and beliefs. It is concerned with wars only so far as these have produced a change in the population or language of a region. It is interested in kings only when these functionaries have retained customs indicative either of priesthood or divinity. It is interested less in legal enactments than in customary institutions, less in official theology than in the beliefs of the people; the acts of politicians concern it not so much as do the habits of humbler folk.

From some points of view anthropology may be considered as a department of zoology. A century ago zoologists were engaged in studying the higher animals, and for a time neglected the "radiate mob." Then all interest was focussed upon lowly forms, and the protozoa occupied a disproportionate part of their attention. Lately, again, their work has been more evenly distributed over the whole field. This choice of groups for special study was not due to mere caprice. The more obvious forms of life were first studied; then attention was focussed upon the simpler organisms; for, from the study of these, the zoologist was able to grasp

[5] Marett, R. R., "Anthropology," p. 1.

the underlying principles of life. These lessons learnt, he was able to attack the problems affecting the welfare of mankind.

So with the student of man. For many centuries historians, philosophers, and theologians have been studying the ways of civilised humanity, though not by the methods of the anthropologist. For, just as they were attracted by the higher groups of men, so were they fascinated by the more conspicuous individuals. During the nineteenth century, students were attracted towards the backward types of humanity, partly because of their very unlikeness to ourselves, and of recent years because they felt that the customs of these peoples were fast disappearing. But from a scientific point of view, the paramount reason was because it was felt that in such simple societies we should find the germ from which human civilisation had begun.

Much of the force of this last argument is disappearing as the evolutionary school gives place to the historical. We are becoming aware that the civilisation of backward peoples is more complex than was at first believed. We are giving up the belief that such people have preserved our ancestral types alive to the present day, for we are realising that they represent not so much our ancestors as our poor relations.

Though we must abandon the ancestral view, and cease to believe that these backward communities represent to-day the conditions under which we dwelt in the past, the institutions of these folk are in many respects less complex than our own, and it is possible to study them from every aspect with far greater ease than we could do in the case of one of the higher civilisations. Since it is the function of anthropology to study man synthetically, this is a great advantage. When dealing with these simpler problems we can evolve a method and a discipline to be applied in more complicated cases. Again, the backward peoples have no written history, and we are forced in this case to restore their past by other means. This has led to the development of fresh methods of attacking the problems of the past, which may prove of value in the case of more advanced communities.

For these reasons the study of backward peoples still has great value for the anthropologist. He has not yet solved all the problems concerned with the dawn of civilisation, nor has he yet perfected his methods and discipline. More workers and expert workers are needed in this field, and so it is that our universities devote the greater part of their energies to training students for this purpose. There are many students, however, who cannot visit wild lands to study the ways of their inhabitants. Some of these, it is true, may sift the material collected by their colleagues, though they will be at considerable disadvantage if they have had no personal experience of the people with which their material deals.

The time seems to have arrived when anthropologists should not concentrate so exclusively upon these lowly cultures, but might carry on their researches into those civilisations which have advanced further in their evolution. Not that I wish to deprecate in any way the study of backward peoples, or to discourage students from researches in that direction; but I would suggest that some anthropologists might initiate a closer inquiry into the conditions of more civilised peoples, in addition to the studies already described.

We have in the Old World three great centres of culture, each of which has been in the van of progress, and each of which has contributed to the advance of the others. These are the civilisations of China, Hindustan, and what I will call the European Region.

Though our relations with China and Japan have been intimate for several generations, and many of our compatriots are familiar with both countries, it is surprising how little we know of either of these people from the anthropological point of view. This is the more to be regretted since for more than half a century Japan has been adopting features from Western civilisation, while there are signs that the same movement is beginning in China. So far those who have made themselves familiar with the languages of the Far East have studied the art, literature, philosophy, and religion of these regions, rather than those aspects which more properly belong to our subject.

What concerns us more nearly in this country is the Indian Region. Here we have a well-defined province, peopled by successive waves of different races, speaking different languages, and with different customs and beliefs—an apparently inextricable tangle of diverse elements in various stages of cultural evolution. A vast amount of material has been gathered in the past, though such collecting has not been proceeding so fast during the last generation; but basic problems are still unsolved, and seem at times well-nigh insoluble. Perhaps it is this superabundance of material, or it may be the apparent hopelessness of the task, which has diminished the interest taken in these studies during the past few years. This attitude is regrettable, and the only redeeming feature is the extremely active and intelligent interest in these problems now taken by various groups of Indian students, especially in the University of Calcutta.

I have suggested that perhaps the lack of interest in such matters among Anglo-Indians, and especially among members of the Indian Civil Service, may be due to the apparent hopelessness of reaching a solution of any of the problems involved. It may also be due to the fact that they are sent out from this country to govern a population with different cultures and beliefs, and traditions wholly unlike those of this continent, without having received in most cases any preparation which will enable them to study, appreciate, or understand an alien civilisation. Thus they misunderstand those among whom they are sent, and are in turn misunderstood. Guiltless of any evil intent, they offend the susceptibilities of those among whom their lot is cast, and acts are put down to indifference which are only the product of ignorance. After making their initial mistakes the more intelligent set to work to study the people committed to their charge, but faced with problems of extreme intricacy, and without any previous training, more often than not they give up the attempt as hopeless.

That candidates for the Indian Civil Service should receive a full training in anthropology before leaving this country has been pleaded time after time by this Section and by the Anthropological Institute, and though I repeat the plea, which will probably be as useless as its predecessors, I would add more. The problems con-

fronting the anthropologist and the administrator in India are of such extreme complexity that it needs a very considerable amount of combined action and research even to lay down the method and the lines along which future inquiries should be made. Such a school of thought, such a nucleus around which further research may be grouped, does not yet exist; the materials out of which it can be formed can scarcely yet be found. Yet until such a nucleus has been created, and has gathered around it a devoted band of researchers, no true understanding will be found of the problems which daily confront both peoples, and the East and the West will remain apart, subject to mutual recriminations, the natural outcome of mutual misunderstanding.

One solution only do I see to this dilemma. For many years past there have been institutions at Athens and Rome, where carefully chosen students have spent several years studying the ancient and modern conditions of those cities and their people. By this means a group of Englishmen have returned to this country well informed, not only as to the ancient but the modern conditions of Greece and Italy. Besides this we have had in each of the capitals of those two States an institution which has acted as a centre or focus of research into the civilisation of those countries. Although the main objects in both cases have been the true understanding of the cultures of the distant past, the constant intercourse of students of both nationalities working for a common end has resulted in a better understanding on the part of each of the aims and ideals of the other. I have no hesitation in saying that the existence of the British Schools at Athens and Rome has been of enormous value in bringing about and preserving friendly relations between the people of this country and those of Greece and Italy.

I cannot help feeling that a similar institution in India, served by a sympathetic and well-trained staff, to which carefully selected university men might go for a few years of post-graduate study, would go far towards removing many of the misunderstandings which are causing friction between the British and Indian peoples. Such a British School in India, if it is to be a success, should not be a Government institution, but should be founded and endowed by private benefactors of both nationalities. It would be a centre around which would gather all anthropological work in the peninsula, while it would enable the British students to arrive at a truer understanding of Indian ideals and help Indians to grasp more fully the relations subsisting between the Indian and European civilisations.

Lastly, we come to the European Region, extending southward to the Sahara, and eastwards to Mesopotamia. Throughout this region the racial basis of the population is similar, though the proportion of the elements varies. Also throughout the region there has been, from the earliest days, free communication and no great barriers to trade and migration.

Until the last fifteen hundred years the civilisation of this area was fairly uniform, though its highest and earliest developments were in the south-east, while the northern zones lagged behind and were on the outer fringe. Nevertheless it formed from palæolithic times one cultural region, and this became more marked and homogeneous during the days of the Roman Empire. Two forces from without destroyed that mighty empire and divided the region into two halves; and as each of these forces adopted different religious views, the European cultural region became divided into two. We have, therefore, to treat the European cultural region as two, the civilisations of Islam and Christendom.

Though the separation of these two halves is relatively recent, their ideals have grown divergent, while the inhabitants of both zones are no nearer to a true understanding of one another. Political difficulties in the Near East are the natural result of such misunderstandings, and the remedy here is to achieve a truer appreciation of other points of view. A more thorough knowledge of the anthropological factors of the case seems to be a necessary preliminary to such mutual understanding, and since the League of Nations and the Versailles Treaty have seen fit to add to our responsibilities in this area, it is an urgent necessity that some of our anthropologists should pay closer attention to the problems of the Near East.

And now with regard to Christendom. Are we to consider that our duties as anthropologists end with alien cultures? Is Christendom so united that misunderstandings cannot arise within its borders? At the close of a great war we can scarcely claim that there is no room for our studies.

There has been a tendency hitherto to regard anthropology as a science dealing with backward peoples, and it has been felt that to apply its principles to neighbouring peoples might be looked upon as an insult. If, however, we agree that all mankind are fit material for the anthropologist's investigations, we need have no hesitation in studying their material culture, social organisation, and religious beliefs, just as already, for practical purposes, we study their languages. There is not a country in Europe in which we may not find features of an anthropological nature which separate its population from the inhabitants of other areas. It is these differences which come to the front when trouble is brewing, and these are the factors which we need to understand if we are to avoid giving offence in moments of national irritation. Constant travel by people alive to the importance of such inquiries will in time so influence the public opinion of many of the nations of Europe that misunderstandings will be less frequent, and national sensitiveness less prone to take offence at words and actions which are not intended to provoke.

But it is not only foreign countries and their inhabitants which the anthropologist needs to study. In every country there are different strata in the population which have different customs and a different outlook. The British Isles are no exception to this rule; history records the successive arrivals of Romans, Saxons, Danes, and Normans, and the study of prehistoric remains shows us that these invasions have been preceded by a greater number in earlier days. Just as the physical type of the Briton is far from uniform, so are his mental outlook and his ideals and beliefs. Quite apart from the differences observable in the different countries which compose our group of islands, we find also that the population insensibly divides itself into classes, differing but slightly except in name from what we know in India as castes. These classes in the British

Isles have had their origin in the successive waves of conquest which these islands have suffered. Individuals have freely passed from one class to another, but though the individuals have changed the classes have remained. Owing to the constant interchange in blood the physical characters of the different classes are much alike, as are their fundamental mental traits, but in material culture, language, social organisation, and to some extent religious beliefs, they differ widely. Here then again, in our own country, there is work for the anthropologist who never leaves these shores.

Turning now to the aims of anthropology and to the means whereby it may become of service to the State and to mankind in general, we see that it is of the utmost importance that those who are sent to govern or administer areas and districts mainly occupied by backward peoples should have received sufficient training in the science to enable them, in the shortest possible space of time, and consequently with the fewest possible initial mistakes, to govern a people whose customs, traditions, and beliefs are very different from their own, without offending the susceptibilities of their subjects.

We are an Imperial people, and during the last few centuries we have taken upon ourselves a lion's share of the white man's self-imposed burden, and the lives and well-being of millions of our backward brethren have been entrusted to our charge. Recent events have, by means of mandates, added largely to our responsibilities in this respect. We, of all nations, cannot disregard this fundamental duty of despatching our proconsuls fitted to undertake these great responsibilities.

But the burden we have undertaken extends not only to backward peoples; we have been called upon to govern or to advise the governments of peoples who have a civilisation little, if at all, inferior to our own, and to whom at one time we have been indebted for much of the culture that we now enjoy. The civilisations of these regions are infinitely more complex, and the people are not homogeneous, but are divided into numerous sections, differing in language, religion, and social customs. In these regions we meet with anthropological problems of infinite difficulty and complexity, on the solution of which depend the peace and well-being of the population. Yet our representatives go to take up their duties in these lands with little or no previous training, and it is only a marvel that errors of tact, due to ignorance, are not more common.

In these civilised regions race consciousness has been growing fast during the last half-century, and errors of tact and manners, which were submitted to in former times, though not with a good grace, are now actively resented, and the old methods of government are discredited. It may not yet be too late to remedy this evil, if no time is lost in giving a full anthropological training to those who are sent to administer these regions.

But we are not only an Imperial people, governing and administering regions with alien populations; we are also a wandering and adventurous people. The nomadic spirit of our ancestors is still alive within us; our ships, like those of the Vikings of old, are to be seen in every sea. So it comes that our people will be found in all lands and all climates from the Arctic circle to the Equator.

All these wandering Britons come in contact with the inhabitants of the lands they visit, creating various impressions, sometimes good, more often bad. Had they a fuller knowledge of the customs and opinions of the people they visit, or even a truer appreciation of the fact that diverse customs and opinions exist and should be respected, we should not have to record the creation of so many bad impressions. Luckily our people, as a rule, have much common sense, and often a desire to please, so this trouble is thus to some extent mitigated; but the difficulties that have arisen from ignorance of the ways of others, from too insular an outlook, in fact, from a lack of appreciation of the anthropological standpoint, are making us and our government heartily disliked in nearly every quarter of the globe. It is to remedy these difficulties, and the danger to the peace of the world which is threatened thereby, that I would advocate an increased study of anthropology by all sections of the community. Herein lies one of the chief means by which our science may become of service to mankind.

It is not my business to draft a scheme for the furtherance of anthropological studies. Two of our universities offer degrees in this subject, and others a diploma; courses of instruction on some sections of the subject are given there and elsewhere. Many teachers of geography are introducing much anthropological matter into their curricula, and there are signs that some historical teachers may follow suit, so that the subject-matter, if not the name, is not unknown in some of our schools. But we have much lost time to make up and the matter is urgent.

We cannot, of course, expect all our people to be trained anthropologists and to understand fully all the ways of the people they may chance to meet in their wanderings. What matters far more is that they should appreciate the fact that different peoples have had different pasts and so act differently in response to the same stimuli. Further, that all this diversity has its value; that we cannot be sure that one culture is in all respects superior to another, still less that ours is the best and the only one which is of consequence. It is not so much the facts that matter as the spirit of anthropology; we need not so much that our people should have anthropological knowledge as that they should learn to think anthropologically.

It is needless for me to remind you that the world is in a state of very unstable equilibrium--that the crust is, so to speak, cracked in many places, and that the fissures are becoming wider and deeper, and that fresh fissures are constantly appearing, not only in distant lands but nearer home. Again, this crust, if I may continue the geological metaphor, is stratified, and there are horizontal as well as vertical cleavages, which are daily becoming more marked. It is to the interest of humanity that these breaches should be healed and the cracks stopped, or we may find the civilisation of the world, which has grown up through long millennia at the cost of enormous struggles, break up into a thousand fragments. Such a break in the culture of the European Region followed the dissolution of the Roman Empire, and more than a thousand years were needed to heal it; nay, some of the cracks then made have never yet been closed.

Anything that may help to avert such a disaster is

important to the human race, and there is no greater danger at present than the alienation of the peoples of Asia and the Near East. Much of the ill-feeling engendered in India, Egypt, and elsewhere is the product of misunderstandings, due to a lack of appreciation on both sides of the opinions and views of the other party, and there seems to be no better method of removing such misunderstandings than a sympathetic study of one another's culture; to this end anthropology offers the most hopeful approach.

Obituary.

DR. DAVID SHARP, F.R.S.

DR. DAVID SHARP, whose name, it has been well said, is a household word wherever the science of entomology is pursued, died on August 27 at his home at Brockenhurst. His love of entomology, the great and continuing enthusiasm of his life, dated from his early childhood. Born in 1840 at Towcester, Northamptonshire, his early years were passed at Whittlebury, Northants, and at Stony Stratford. His parents later moved to London, and it was at Loudoun Road, St. John's Wood, that Herbert Spencer was an inmate of Sharp's father's house, as Spencer himself has related in his autobiography. Sharp himself said that his youthful intimacy with Spencer had influenced him considerably, and throughout his life he retained in Spencer's work an interest which found expression in the publication in 1904 of an article on "the place of Herbert Spencer in biology."

Sharp was destined by his father for a business career, but, finding this uncongenial, he studied medicine in London and afterwards at Edinburgh University, where he graduated in 1866 with the degrees M.B. and C.M. Specialising in the treatment of mental illnesses, he resided for some years at Thornhill in Dumfriesshire. He left Scotland in 1884 and lived at Shirley Warren, Southampton, and afterwards at Wilmington, near Dartford, Kent. Early in 1890 he was appointed curator of the insect collections of the University Museum of Zoology, Cambridge, a post which he resigned early in 1909. He then retired to Brockenhurst, where he passed the rest of his days.

Most of his multitudinous writings are systematic works on the Coleoptera, to which he devoted the greater part of his life, but many deal with other insects or with life-histories, or have a still wider bearing, for his learning extended to a wonderful degree over the whole field of entomology. He had an unrivalled knowledge of the British Coleoptera, and already in 1869 had published a monograph of nearly 200 pages on the obscure genus Homalota. His list of the Coleoptera of Scotland appeared in the early volumes of the *Scottish Naturalist*, and he published two catalogues of the Coleopterous fauna of Britain, the second in collaboration with Canon W. W. Fowler. His numerous other studies of British beetles form a series of papers continuing to the last years of his life.

Sharp's biggest works on foreign Coleoptera are the monograph of water-beetles (Dytiscidae) published by the Royal Dublin Society in 1882, and his contributions to the "Biologia Centrali-Americana." In the latter he wrote the whole of the volume on Adephaga and Staphylinidae, more than 800 pages, the greater part of the volume on Clavicorns, and three other important sections. He also published in 1876 a paper of nearly 400 pages on the Staphylinidae of the Amazons. On New Zealand beetles, a fauna in which he was specially interested, he produced a long series of memoirs. One can barely allude to his papers on the beetles of Japan, an important series, and to others on those of Ceylon, Southern India, the White Nile, etc., with many more, far too numerous to mention. Systematists, knowing the work required for the production of a single careful description, will appreciate the immense amount of toil needed to achieve these results. Special mention must be made of Sharp's work on the faunas of islands. A series of earlier papers on Hawaiian beetles was but the prelude to his labours as secretary of the committee appointed in 1890 to investigate that fauna, and as editor of the three large volumes of the "Fauna Hawaiiensis," of which he himself wrote several considerable parts. He was moreover a member of the committee appointed in 1888 to examine the flora and fauna of the West Indies.

Of his more general writings undoubtedly the best known are the two volumes on insects in the "Cambridge Natural History," published in 1895 and 1899 respectively, which at once became standard works. His memoir (1912) written in collaboration with Mr. F. Muir on "the comparative anatomy of the male genital tube in Coleoptera" is a masterly treatise, on the production of which the breadth of his learning was brought to bear. In 1873 appeared his pamphlet on "the object and method of zoological nomenclature," in which he elaborated the view that nomenclature requires, for the maintenance of continuity of knowledge, fixed names for the species of animals, while changing ideas as to classification need shifting names for their expression. He advocated that the two names, generic and trivial, originally given to an animal should always be preserved intact, even though it may subsequently be placed in several different genera at different periods. He held also that the analytic system of Linnaeus, in which species are treated as fractions of genera, broke down almost at once, and that only by a synthetic system could progress be made; that species must first be rightly understood, and then grouped into genera. These ideas he carried into practice in his monograph of the water-beetles, but in his later works he did not adhere strictly to the system of naming there used. In the introduction to that monograph he also expressed some of his views on the origin of species, an example of his cautiousness with regard to accepted ideas. He also discussed the phylogeny of insects in the proceedings of the Congress of Zoology held at Cambridge in 1898; and the senses, especially the sight, of insects in his retiring presidential address to the Entomological Society (1888). To him are due the articles on "Termites" and "Insects" in the volumes of the "Encyclopædia Britannica" issued in 1902, as is also (in part) that on "Hexapoda" in the later edition (1910).

Perhaps Dr. Sharp's greatest service to zoology was in connexion with the "Zoological Record." Of this he became general editor in 1892, and he only laid the work down a few weeks before his death. Throughout this period he was also recorder of all the literature on insects. He improved the volumes immensely, and raised the classified subject-index to a wonderful degree of efficiency.

So far allusion has been made only to his writings, but he also excelled as a field-worker and collector. Ever laying great stress on the importance of the collection and permanent preservation of material, he published several articles on these points. His collection of British Coleoptera is as fine as any, and he also made a very large foreign beetle collection, the greater part of which, consisting of some 150,000 specimens, was acquired by the British Museum in 1905. During his time at Cambridge he amassed a large amount of material for that Museum. His fine library was recently purchased by the Cawthron Institute at Nelson, New Zealand.

Dr. Sharp was a wide reader, and though of rather slight bodily frame he had, even to an advanced age, great powers of endurance as a field-worker, and an almost unlimited capacity for mental work. No time was ever lost in picking up the threads of his work, so that even short intervals were used to the full. He was Hon. M.A. of Cambridge; elected F.R.S. in 1890; fellow, and former councillor of the Zoological Society. He joined the Entomological Society in 1862 and was president in 1887 and 1888, besides holding lesser offices on several occasions. He was also an honorary or corresponding member of the New Zealand Institute and of the principal entomological societies of the world.

H. S.

Dr. William Kellner.

Dr. William Kellner, who died at Charlton, on September 12, in his eighty-third year, was born at Frankfort in 1839, and received his scientific training under Prof. Wöhler at Göttingen, finally obtaining his Ph.D. degree in that university. He became a Fellow of the Institute of Chemistry in 1878 and served on the Council from 1895 to 1898. In 1862 he came to England as assistant to Sir Henry Roscoe, at Owens College, Manchester, whence, in 1864, he went to Woolwich and joined the staff of the War Department chemist (Sir Frederick Abel). In his early years at Woolwich Dr. Kellner was engaged in the varied general work of the chemical department. Later his main work became investigatory and experimental, both in connexion with explosives, as also to meet the requirements of the various Commissions and Committees on which the War Department chemist was a prominent member; of these the "Royal Commission on Accidents in Mines" and "The Explosives Committee" (appointed in 1889 to produce a smokeless powder for the Service) may be mentioned.

Dr. Kellner also devoted much work to the production of an apparatus for determination of the flashing point in oils, and was largely responsible for the Abel flash point apparatus, eventually perfected; in collaboration with Sir Boverton Redwood he carried out an exhaustive series of tests with this apparatus.

As a scientific worker Dr. Kellner was painstaking and methodical, displaying much skill in devising experiments to assist in elucidating the various problems confronting him in the course of his work. As regards practical results his most important work was in connexion with the evolution of cordite, much of the more difficult research and experimental work leading to the production of this explosive being carried out by him in the chemical department at Woolwich Arsenal; in spite of the numerous smokeless powders which have been brought into use since, the fact that, after a period of thirty years, cordite still remains the British Service propellant for army and navy use, is perhaps the best testimonial to the thoroughness of his work in this direction.

In 1892 Dr. Kellner succeeded Sir Frederick Abel as chemist to the War Department, and in addition to the duties of this office, served as an associate member of the Ordnance Board and as consulting chemist to the Royal Gunpowder Factory at Waltham Abbey; he retired from the service in 1904.

We much regret to announce the death on October 2, at fifty-eight years of age, of Col. E. H. Grove-Hills, F.R.S., formerly head of the Topographical Department of the War Office and the author of a number of papers on astronomical subjects.

Current Topics and Events.

H.R.H. the Prince of Wales has graciously accepted an invitation to be present at a joint dinner of the Institution of Mining Engineers (representing coal-mining engineering) and the Institution of Mining and Metallurgy (representing the mining of minerals other than coal) to be held on Thursday, November 16. The dinner will be held at the Guildhall by permission of the Corporation of the City of London.

In his presidential address to the British Association at Edinburgh last year, Sir Edward Thorpe referred to the difficulty which is encountered by many workers in science of being unable to obtain all the scientific books they require owing to lack of means. Sir Robert Hadfield has now generously offered to contribute a sum of 50*l*. per annum for three years, to be expended in supplies of books to those who are engaged in scientific pursuits and are unable to purchase for themselves. The council of the British Association has at present under consideration the best means of allocating this gift.

Among many important accessions of manuscripts to the Library of Congress (Washington) noted in the librarian's report for 1921, we observe the papers and correspondence of the late Major-General W. C. Gorgas, and the diaries and note-books of Jean Nicholas Nicollet, the explorer of the upper Mississippi, Missouri, Red, and Arkansas rivers in the first

half of the nineteenth century. The division of maps has received many rarities. An increase of receipts from the Central Powers is noted. "A large number of these were theses of German universities and institutes of technology, which goes to show that the work of these institutions was carried on during the war without interruption."

ACCORDING to letters received by the last mail, the International Congress of Americanists at Rio de Janeiro has been a very great success. An enormous mass of papers was presented, all of which the Government proposes to print in full. At the close of the meeting the majority of the members took advantage of the delightful excursions which had been arranged for their benefit. After some discussion it was decided to hold the twenty-first session of the congress in 1924 in Holland by invitation of the Dutch Government, and in 1925 at Gothenburg, Sweden, by invitation of that town, where the museum is in charge of Mr. Erland Nordenskiöld, the well-known authority on South America. In 1926 the congress will meet in Philadelphia.

THERE are welcome indications that the work of investigating our national antiquities, interrupted by the outbreak of the war, is now being revived. The Congress of Archæological Societies, in union with the Society of Antiquaries, London, has just issued the first number, for 1921, of "The Year's Work in Archæology." This useful publication gives lists, arranged in the three kingdoms and their counties, of the progress of exploration. In a valuable supplement we have a list of the more important papers on the subject published by the local societies, and though a large number of these societies are affiliated to the Congress, there is still room for the association of local workers in this important enterprise. The Congress makes an appeal for contributions in order to effect the purchase of Cissbury Ring, near Worthing. As this pamphlet shows, there are still considerable vandalism and destruction of important monuments; the Congress protests specially against the destruction of a portion of the Middlesex Grim's Dyke at Pinner Green, and other examples are quoted in the Report. Much important work is being done in connexion with the Archæological Survey, and the president, Sir Hercules Read, remarks that there are many signs that we are at last becoming a civilised nation, as is shown by the Ancient Monuments Act and the appointment of the Congress Secretary, Mr. Crawford, to the newly created post of Archæology Officer at the Ordnance Survey.

THE *Toronto Star* of July 6 last has a note on a method of marking trails leading to springs of water which is practised by Indians of Western Texas. Two heaps of rock roughly heaped together, one about three feet high, the second a little lower, are placed beside the track, usually on an elevation commanding a view of the country for some five miles or more. A sight is taken from behind the larger heap, over the smaller, to some object on the horizon, such as a tree or clump of bushes. Near this object will be found a second pair of heaps of rock sighting on a second objective. This process is continued until the spring is reached. This primitive method of sighting a trail is of interest in connexion with the suggestions put forward by Mr. Alfred Watkins in his "Ancient British Trackways," recently noticed in these columns. He argued that many of the older roads in this country could be assigned to pre-Roman times on the evidence of what it was presumed were sighting marks, which must have been used in much the same way as the Indians are said to make use of these heaps of rocks. Mr. Watkin's theory, as was pointed out when it was under notice, undoubtedly holds good in many cases, especially in connexion with natural objects; in others, particularly in the case of mounds, moats, churches, etc., it appears more open to criticism.

THE Fifth Annual Report of the Imperial War Museum has recently been issued by H.M. Stationery Office, price 9*d.* (post free 10½*d.*). It is typewritten on 8 folio pages and reproduced by a multicopier. This at any rate shows a desire for economy, calculated to appease the public. The work of the museum during the year 1921–22 consisted in a complete survey of the whole collection, elimination of items of no technical value or historical interest, and the compression and concentration of the more valuable exhibits under definite headings and groupings. This was particularly the case with the Munitions and Air Force exhibits. Stress is laid in this report on the technical value of the collections and on the fact that many objects of our everyday life during the War have been preserved in this museum while they have disappeared elsewhere. Allusion is made to the proposal to utilise two galleries at present occupied by the Science Museum and certain galleries now occupied by the Imperial Institute. These proposals have, it will be remembered, evoked a great deal of opposition. The committee appointed to investigate on them has reported to the Cabinet, but no decision has yet been reached.

DR. DAVID STARR JORDAN proposes that the International Commission on Zoological Nomenclature should reject the following works from consideration under the Law of Priority:—Gronow, 1763, "Museum Ichthyologicum"; Commerson (as footnotes in Lacépède, "Hist. nat. des poissons," mostly 1803); "Gesellschaft Schauplatz," 1775–1781, an anonymous dictionary accepting the pre-Linnaean genera of Klein; Catesby, 1771, "Natural History of Carolina, Florida, and the Bahamas" (1731–1750), revised reprint by Edwards; Browne, 1789, revised reprint of "Civil and Natural History of Jamaica"; Valmont de Bomare, 1768–1775, "Dict. raisonnée universelle d'hist. nat." (several names accidentally binomial). By this all systematic names published as new in those works will be rejected as of the dates in question, but will remain available as of the dates when they were adopted by later authors of unquestioned status. It is hoped that the proposed action will extricate zoologists from an impasse into which they have been led by a divergence of views respecting the terms

"binary" and "binomial." Zoologists who may have opinions on this proposal, which they desire to lay before the Commission, are invited to communicate them in writing to any member of it, so that they may reach the Secretary at Washington, D.C., U.S.A., before September 1, 1923. They would do well first to consult Opinions Nos. 13, 20, 21, 23, and 24 issued by the Commission.

THOSE who are familiar with the history of the elements will know, and those who are not familiar can easily inform themselves of the fact, that Lavoisier included among the elements both light and heat, which he classified along with oxygen, nitrogen, and hydrogen. A more detailed study of his "Traité élémentaire de chimie" will show that before discussing the compounds of oxygen, nitrogen, etc., with other elements, he devoted a brief chapter to observations on the compounds of light and heat with different substances. The rapid development of chemistry soon led to the abandonment of these imponderable elements, which came to be regarded as different manifestations of energy. It is, therefore, of interest to read in the *Pharmaceutical Journal* of August 12 a letter in which Mr. Carol A. Cofman Nicoresti, B. ès Sc. et Lettr., announces, as a final conclusion of his investigation of gaseous volume and pressure, "that heat and light are both material substances, that they enter into chemical combination with other elements, and that they are *thrown out* by *chemical reaction*." It is perhaps a compliment to Lavoisier that even his untenable hypotheses should thus undergo resurrection; but that they should be put forward as original can only be taken as a sign of imperfect chemical education. In one other respect Mr. Nicoresti's growth as a student of chemistry appears to have been arrested at a period more than a century earlier than Lavoisier, since he asserts that after careful consideration he is driven to the conclusion "that there are no such things as *gases*, but that there is only *one* gas in nature. That explains why the gaseous laws *are so uniform*." In this respect he apparently adopts the views of Boyle and Mayow, and his chemical education appears to have been carried forward but little further than the period of Agricola, who "hinted that the gases in mines were manifestations of malignant imps."

IN the will of Prince Albert of Monaco, who died on June 26 last, there are noteworthy gifts for scientific purposes. His farm at Sainte Suzanne is left to the French Academy of Agriculture, and the wish is expressed that the estate should remain a place for agricultural experiments, to demonstrate what science and determination can obtain from sterile lands. Dr. Jules Richard will receive 600,000 francs to enable him to complete literary and scientific works in progress, including the results of the oceanographic cruises and the preparation of the Bathymetric Chart of the Oceans. The proceeds of the sale of the yacht *Hirondelle*, all books and publications of a scientific nature, as well as certain personal effects, will go to the Oceanographic Institute at Paris and Monaco, while the Institute of Human Palæontology in Paris is to receive any personal effects relating to the work carried on there. The Paris Academy of Sciences will receive a million francs, the income of which is to provide a prize to be awarded every two years, the nature of the prize to be indicated by the Academy, according to the needs of the moment; a like sum is bequeathed to the Academy of Medicine for a similar prize.

WE learn from the *British Medical Journal* that the Carnegie Hero Fund trustees have awarded a medallion and an annuity of 130*l*. to Dr. John Spence of Edinburgh, in recognition of his valuable and heroic work in radiology. Dr. Spence was among the first in Scotland to take up research in X-rays and medical electricity, and as a result of radiological experiments he sustained serious damage to both hands, necessitating amputation of the right forearm. Dr. Spence is still carrying on his work as radiologist at Leith Hospital and Craigleith Hospital, Edinburgh.

H.R.H. THE DUKE OF CONNAUGHT has consented to unveil the roll of honour which has been erected at the Institution of Civil Engineers to the memory of its members and students who lost their lives in the war. The ceremony will take place at 4 P.M. on Friday, October 27.

AT the next ordinary scientific meeting of the Chemical Society on October 19, Prof. T. M. Lowry will read a paper entitled "The Polarity of Double Bonds. An Extension of the Theories of Lapworth and Robinson," and it is hoped that a general discussion will take place. On Thursday, October 26, at 8 P.M., a lecture entitled "The Significance of Crystal Structure" will be delivered by Sir William H. Bragg, in conjunction with Prof. W. L. Bragg. This meeting will be held in the lecture hall of the Institution of Mechanical Engineers, Storey's Gate, S.W.1.

WEATHER reports from Captain Amundsen's arctic expedition will be sent from the ship *Maud* and included in the collective message broadcasted by wireless from the Eiffel Tower daily at 11 h. 30 m. G.M.T. These observations, according to the *Meteorological Magazine*, will commence on October 15.

IT was announced at a meeting of the Chemical Society on October 5 that Prof. J. F. Thorpe had been nominated to fill, until the next Annual General Meeting, the office of treasurer, rendered vacant by the resignation of Dr. M. O. Forster, recently appointed Director of the Indian Institute of Science at Bangalore. Dr. J. T. Hewitt was nominated to fill the vacancy in the list of vice-presidents caused by Prof. Thorpe's appointment.

FROM the Report of the Castle Museum Committee to the Town Council of Norwich for 1921, just received, we learn that the Norwich Education Committee has appointed a special demonstrator to conduct round the museum organised parties of about 25 pupils accompanied by teachers. During the year 19,801 attendances were recorded, each class attending the complete series of demonstrations in sixteen weekly

visits. The first lecture dealt with the purpose and methods of a museum, the next thirteen with various forms of animal life, the fifteenth with the early history of man, and the last with the story of the rocks and fossils. We understand that other Education Committees think of following this excellent example.

MR. H. E. STONE, of Sidcup, Kent, has forwarded to us a photograph of a specimen of *Datura Stramonium* which has attained a height of 28 inches with a foliage span of 58×24 inches, and bears 25 well-developed seed-pods. The plant is undoubtedly a fine specimen, although not unusually large. The largest plants are often found on rubbish-heaps made up of garden refuse, and also as weeds in cultivated ground. Such plants benefit by their isolation as much as by rich food material. Cultivated plants are often allowed to stand too close together to be able to develop to their full extent, while they usually lack the rich food material available in the case of isolated plants, and particularly those that have sprung up as weeds.

THE London agency of the Smithsonian Institution, Washington, which, since 1871, has been carried on by Messrs. William Wesley and Son, 28 Essex Street, Strand, London, has been removed to the premises of the new firm of Messrs. Wheldon and Wesley, Ltd. (incorporating William Wesley and Son), at 2, 3, and 4 Arthur Street, New Oxford Street, W.C.2. The large number of societies, museums, and institutions which forward their publications for transmission to their American correspondents through the International Exchange System of the Smithsonian Institution are requested to forward their consignments in the future to 2, 3, 4 Arthur Street, New Oxford Street, W.C.2.

Our Astronomical Column.

THE SUNSPOT PERIODICITY.—Many attempts have been made to correlate the 11 year period of spot variation with the 11·86 year period of Jupiter's revolution. The latter, as it stands, differs too widely, and it is necessary to combine it with some other period. Prof. T. J. J. See, in a special number of *Astr. Nachr.*, vol. 216, attempts to combine it with 9·93 years, which is the period in which Jupiter gains a semi-revolution upon Saturn. He weights these two periods in the ratio 1·828 to 1, this ratio being the square root of that of Jupiter's mass to Saturn's mass. The result is 11·18 years, which is close to the sunspot period. But it is to be noted that while the 11·86 year period depends wholly on Jupiter, that of 9·93 years depends on both planets, so that the appropriateness of the above ratio is far from clear; apart from this the resulting period of two wave motions does not depend on the ratio of their amplitudes, but on the time that one takes to gain a revolution on the other. For example, the period from spring tides to spring tides is a semi-lunation, and this would not be altered by an alteration in the relative heights of solar and lunar tides.

It will be remembered that Prof. E. W. Brown also endeavoured to get the sunspot period from Jupiter and Saturn, though in a different manner. He was successful in predicting that the 1907 maximum would be a late one. Mr. E. W. Maunder directed attention to the cyclical shift of the spots in solar latitude synchronously with the variation in activity, which seems to indicate an internal rather than an external origin.

FLAMSTEED'S LETTERS TO RICHARD TOWNELEY.—This very interesting packet of letters was recently found at the Royal Society. Dr. Dreyer contributes a long article to the *Observatory* for September describing their principal contents. A few points may be mentioned here. Flamsteed was prompt in accepting Roemer's explanation of the annual inequality of Jupiter's satellites, due to the finite velocity of light. He studied refraction at low altitudes by measuring the change in the apparent vertical diameter of the sun.

We find from his notes on the great comet of 1680 that he was at that time still a believer in the vortices of Descartes, though he makes a note on Newton's different opinion. By 1686 Flamsteed had apparently become convinced of the overthrow of the system of vortices; after alluding to the progress in the printing of the "Principia" he expresses his satisfaction in the immense gain that the new system will afford in the study of the planetary motions, "so that in the room of mourning I congratulate my own happiness."

It is rather melancholy to note how his opinion of Halley gradually changed from admiration to jealousy and suspicion. This seems to have been largely due to the association of Halley with Hooke, whom Flamsteed considered an enemy.

We share Dr. Dreyer's hope that the letters will be published in full.

PERTURBATIONS OF WOLF'S COMET.—Allusion was lately made in these notes to the work of M. Kamensky on this comet from its discovery in 1884 to the present time, and to the large changes in its orbit likely to arise from the very near approach to Jupiter this year. He has now calculated these changes, and gives the results in *Astr. Journ.* No. 807. The least distance occurred on September 26, when it was one-eighth of a unit, so that Jupiter's direct action was 1½ times that of the sun, and the assumption of elliptical motion ceases to be the smallest approximation to the truth. On the other hand, a remarkable approximation may be obtained by assuming the motion to be in a hyperbola about Jupiter, which is equivalent to treating the action of the sun on the two bodies as identical during the time of near approach. Incidentally this gives an opportunity for using the equations for hyperbolic motion, which are given in the text-books but very seldom employed. The results obtained by this simple method are quite close to those of the more rigorous investigation. A curious point is that the present perturbations are about equal in size but opposite in direction to those at the approach of 1875, so that the comet now returns very nearly to its 1875 orbit. The period is increased from 6¾ to 8¼ years, and the perihelion distance from 1·53 to 2·40. It fortunately happens that at the next perihelion passage, 1925, Oct. 28.4, the comet will be almost in opposition, so that the distance from the earth will attain its minimum value, 1·40. Prof. Kamensky hopes that it may not be beyond visual or photographic reach with large instruments: if it should be found, most of the credit will belong to him; if not seen then it will almost certainly be permanently lost.

Research Items.

THE ROMAN BALANCE IN SOUTH AMERICA.—Mr. Erland Nordenskiöld has reprinted from the journal of the Société des Américanistes de Paris (N.S. vol. xiii., 1921) an article sub-entitled "Emploi de la balance romaine en Amérique du Sud avant la conquête." He produces evidence, with a full bibliography of authorities, to show that this invention was not confined to the Old World, but was found in the New World before the discovery of America.

ANTHROPOLOGY IN THE CHILTERN HILLS.—In the Journal of the Royal Anthropological Institute (vol. lii. Part 1), Mr. W. Bradbrooks and Prof. F. G. Parsons publish an elaborate memoir, with a long series of measurements of skull form, on the population of the Chiltern Hills, in which they arrive at the following conclusions: in this comparatively isolated area about half the working-class male people can trace their ancestry back to three generations in some part of the area; the hair colour is rather darker than Beddoe found in the Eastern and East Midland Counties, and the proportion is higher than in any other part of Great Britain, except the South-western Counties and Wales; the eye colour is identical with that of London and the East Midlands; the average cephalic index, 77.7, is practically that of the modern working man in London, and the average height, 5 ft. 7 in., is that of the black-haired individuals. Thus, the present-day inhabitants of the North Chiltern area, who are not recent immigrants, are distinctly darker haired than those surrounding them, and this darkness appears to be due to the survival of a great proportion of Neolithic or Mediterranean blood in the district.

DISTRIBUTION OF FUTURE WHITE SETTLEMENT.—The problem of the potentiality of the world for white settlement is attacked quantitatively by Dr. Griffith Taylor in the *Geographical Review* for July. The world is divided into economic regions which coincide in the main with Herbertson's natural regions. The areas of these regions are determined by planimeter measurements. The factors influencing human settlement are grouped under four headings which comprise the dominant controls—temperature, rainfall, location, and coal reserves. Fisheries have local rather than general importance and are ignored. From the values of each of these four controls a quadrilateral graph, the econograph, is constructed for each region, and the area of the graph is found to represent approximately the habitability of the region concerned. The econograph is a rectangular figure formed on four axes which represent, respectively, the average annual temperature, the average annual rainfall, the average elevation, and the estimated total coal reserve of the region. In what Dr. Taylor believes to be the ideal region these values would be 55° F., 50 in., sea-level, and 200×10^4 tons per square mile. The comparative value of these controls was apparently reached by assuming various values and testing them against the actual population map of Europe. By this means Dr. Taylor decided to give the temperature control double the weight of the rainfall and allow the coal factor, if large, to have equal weight with optimum temperature and rainfall combined. The ideal econograph represents 1000 units. All the seventy-four regions of the world have values below this ideal. The last step was to plot on a map of the world the numbers representing the areas and draw lines of habitability, called isoiketes. This map is of great interest as a partially successful attempt to forecast the future growth of white settlement.

MOSQUITO INVESTIGATIONS.—Since the statement was made by Messrs. Carter and Blacklock that *Anopheles plumbeus* is a potential carrier of malaria in this country, it having been experimentally infected by them, considerable interest has been taken in the habits and distribution of the species in Britain. Following studies made by these authors in the Liverpool district and in the Isle of Man, an inquiry was instituted by the mosquito investigation committee of the South-Eastern Union of Scientific Societies, acting on behalf of the Ministry of Health. The committee now announces that this special inquiry is concluded, and that *A. plumbeus* has been shown to be exclusively sylvan in habits, and to be widely distributed in England, occurring, when searched for, in almost any area in which are found beech, sycamore, chestnut, or other trees with water-containing rot-holes. The committee is now turning its attention to the mating and egg-laying habits of *A. plumbeus* and other species, which are still imperfectly known, and invites co-operation from observers in all parts of the country in elucidating these matters.

MUSCARINE.—In the Journal of the Chemical Society for September, Dr. Harold King, of the National Institute for Medical Research, records the isolation of muscarine, the highly potent and toxic principle of *Amanita muscaria*, the Fly Agaric, a common fungus of our birch woods. Muscarine has been the fertile subject of controversy among chemists and pharmacologists for more than fifty years, and it is now shown that the pure material differs essentially from the original claims as to its properties and constitution made by Harnack, upon whose work the whole of the subsequent edifice has been erected. There is no evidence that muscarine is related to choline or is a quaternary base. More than ordinary interest is attached to muscarine owing to its extreme specificity of localisation in the mammalian body and its complete antagonism by atropine.

A NEW SPECTRO-POLARIMETER.—Messrs. L. Bellingham and F. Stanley, Ltd., of 71 Hornsey Rise, have designed and provisionally protected a polarising prism which can be used either in the visible or ultra-violet region of the spectrum. The prism is constructed from one solid piece of Iceland spar cut in such a manner with respect to the crystallographic axis, and of such a length of side, that the extraordinary ray only is transmitted while the ordinary ray is absorbed at the sides. Two such prisms are placed side by side in a suitable mounting. Before being placed in contact the sides of each prism are ground away to give the required length of dividing line between the halves and also to produce the necessary half shadow angle. To provide a sharp face edge one of the prisms is allowed to project in front of the other, and the two are then bound together. It is claimed that such an arrangement is absolutely permanent and that the extinction is perfect. The entire absence of cement relieves the prism of all strain, and eliminates the possibility of light being diffused from particles in the cement or from scratches on the cemented surface. By employing such a polarising prism Messrs. Bellingham and Stanley have been able to construct a polarimeter which can be used either for visual observation, in conjunction with a mercury lamp, or for photographing the entire spectrum between wave-lengths 230 $\mu\mu$ and 800 $\mu\mu$ at one exposure.

The Fauna of the Sea-Bottom.[1]

By Dr. C. G. Joh. Petersen, Director of the Biological Station, Copenhagen.

Studies of the fauna of the sea-bottom are of essential zoological significance, and many scientific questions as well as important fishery interests depend upon them. The subject, however, is so extensive that I must confine myself mainly to the different methods adopted for the investigation of the fauna of the sea-bottom.

Since 1883 I have investigated Danish waters by means of the dredge; it was my task then to give on charts the distribution, especially in the Kattegat, of every single species of marine animal, to understand the laws ruling the distribution of the animals on the sea-bottom (the cruises of the gunboat *Hauch*). Different specialists had each a group of animals to work out, and a great number of charts were printed, but I did not feel quite content with my first publication, although something was cleared off by that method. The method was, and is still, the usual one for such investigations.

Many years later the question was put before me: Why does the plaice in the western Limfjord grow very slowly, but very quickly in the middle of the Limfjord? The answer required first of all a quantitative investigation of the amount of plaice-food in both places. A small bottom-sampler on a pole, long enough to reach the bottom in the shallow fjord was made in the 'nineties of last century and proved that much food was to be found in both places; the difference in growth-rate of the plaice was found later on to depend not only upon the amount of food on the bottom, but also upon the different number of plaice living there on each square mile. The idea of overcrowding for sea-fishes was introduced for the first time.

Many years later I constructed a new bottom-sampler fastened to a wire; this I have used everywhere in Scandinavian waters down to a depth of 300 fathoms. It was my idea at first to compare the amount of fish-food per sq. metre in the Limfjord with the amount of fish-food per sq. metre in our remaining waters by means of the bottom-sampler; but I soon found it difficult to compare the animals from one water with those of another; in some places the animals were small and of great value for fishes, in others the animals were bigger and built up of carbonate of lime (chalk) mainly, and with a great content of water; chalk and water being of course of little importance as food in the sea for other animals, I realised that I should compare, first of all, the amount of food in places with the same kind of animal population, and I had to map out these places.

The bottom-sampler taught me that we have about eight such different animal communities in Danish waters from 0 to 300 fathoms, characterised by numerous large and characteristic animals. They may be echinoderms, bivalves, crustacea, etc., but are all animals living mainly on detritus, not rapacious animals. These last named are necessarily always scarcer than the more peacefully living animals, as the grass-feeding animals on the dry land are more common than tigers and lions.

One thing puzzled me in the beginning very much; the bottom-sampler showed in many hauls the most uniform content in the sieves in the same animal community, then suddenly it came up filled with quite different animals, *Modiola modiolus*, Trophonia, *Ophiopholis aculeata*, etc., without any corresponding difference in the depth or in the nature of the bottom. How is this to be explained?

[1] Opening of a discussion held in Section D (Zoology) of the British Association at Hull on Sept. 7.

All these new organisms were animals living not in the bottom like ordinary animals, but above the bottom, originally fixed to a small stone or a shell, as on a heath we may find lichens on stones, not heather, or as in a beech-wood, on stones we find mosses, not flowers; strong currents may help to nourish such an *epi-fauna* with its often enormously rich animal life. Every object on the sea-bottom, a stone, a shell, a wreck, living plants, may give rise to such epi-faunas; within the same community on the level sea-bottom there is the same epi-fauna, but in different communities different epi-faunas may be found. The epi-fauna is, as a rule, scattered over the bottom in spots, and it is not always easy, in single cases, to say what is the reason for its existence; it is therefore not possible to give its distribution on a chart; you may give it on the spots where you have found it, but you never will be able to give all the spots existing on the bottom. On rocky coasts the epi-faunas are dominating; the coral reefs are a kind of epi-fauna, built up mainly of chalk and water; they are of very little importance as fish-food.

In contradistinction to the distribution of the epi-faunas the communities of the level sea-bottom are of a very uniform distribution, in such localities as in Danish waters and in the North Sea. Their distribution may be easily mapped out, and their content of fish-food and other animals quantitatively determined. We have taken thousands of samples, each of $\frac{1}{10}$ sq. metre, with the bottom-sampler in Denmark, and they have nearly always shown several animals, worms, bivalves, Ophiuridæ, etc., in each; only one or two samples of them have shown no animal content.

By means of the bottom-sampler we may, therefore, using the most frequently occurring organisms, easily map out the communities of the level sea-bottom, and determine its content of fish-food.

The theory of probability will indicate the degree of accuracy; many samples will give, as a rule, more and more exactitude. We may determine how the number of organisms varies at different seasons and in different years. If we examine what the fishes eat of these organisms we may determine whether they are good or bad areas for this or that species of fish, and may get a fair idea of the productivity of the sea-bottom as a whole, not forgetting that all the small, fast-growing, short-living animals are often to be reckoned as yearly production, whereas the bigger, longer living animals must be reckoned by means of another method. We may get an idea of the whole metabolism of the sea—but I must not go too far in mentioning these problems.

With a good steamer I could in one month map out the whole of the North Sea as to its animal communities. I would take between 500 and 1000 samples spread over the whole of the North Sea, out to the 100-fathom line, about one or two per hour. Using a bottom-sampler of 0·2 sq. m. I should then have taken up only the animals of an area at 100-200 sq. m., but I am sure that I should get all the species of the common uniformly-distributed animals of the whole area, and I should be able to give a rough-sketched map of the animal communities. If we used a bottom-sampler on a heath only once, we should catch heather, and so in the sea, I should not catch many rare animals, but I do not care for rare animals; the main thing is to know the animals that make up the great bulk of the bottom population, to know their distribution and their weight per square mile. If you wish for greater exactitude than

this first trip could give, you may take more stations and investigate smaller areas more carefully.

I am glad to be able to say that in 1921 Dr. Russell, on the English steamer *John Bligh*, made the first trip across the North Sea with my bottom-sampler, guided by my assistant, Dr. H. Blegvad; they found some of the same communities between Lowestoft and Esbjerg as we know from the Kattegat.

Thanks to the bottom-sampler we can now speak about areas with a Venus mussel community, an *Amphiura filiformis* community, a *Brissopsis Amphiura chiajei* community, and so on, as we on land speak about a heath, a beech-wood, a meadow, etc.; we are also able to get a quantitative idea of the amount of animals on the sea-bottom, and are able to follow seasonal or other variations therein.

A dredge will sometimes give us, when well used, a bagful of animals, belonging to the epi-fauna as well as to the ordinary communities, and taken up from all the communities it has been towed over. The dredge is inclined, moreover, to take all animals *on*, not *in*, the bottom, and its content is therefore not a true illustration of what is living *in* or *on* the bottom, but a mixture mostly of epi-fauna from different communities, without giving the slightest idea of quantity per square metre. The content of a dredge and a bottom-sampler used on the same station will very often give quite different collections of animals.

The dredge has given excellent information to zoologists wishing to collect rare animals for preservation in alcohol, and for dredging oysters, and so on, but a true illustration of the fauna on the sea bottom it never has given and never will give.

I admit one thing: it is easy for me to speak and write about the bottom-sampler work, but it never will be well understood without seeing the work going on on board ship; many men of science from Europe have seen how quickly the sampler may be used, like an ordinary sounding machine, and how well it works. I should be glad to welcome many more visitors at the Danish Biological Station, not only to see the bottom-sampler working, but also to be able to discuss with them the problems which have arisen in my mind while using this method during the last 10 to 12 years.

It was a Dane, O. Fr. Müller, who first introduced the dredge in northern Europe for scientific use, and it will always be used by zoologists and for special purposes, but only the bottom-sampler is able to give a true and quantitative representative illustration of the bottom fauna.

Finally, I wish to say that to have a bottom-sampler and to use it is not enough to become a great marine biologist; it depends much upon the possession of working ideas. The bottom-sampler is not able to solve every question; it cannot, *e.g.*, take animals living very deep in a hard bottom, and the apparatus must be modified for special work, according to the size of the ship used, the depth at which you are working, etc., and it is necessary to supplement the investigation by means of other apparatus, fishing-gear, dredges, etc. But without quantitative work it is not possible to understand the principal features of the fauna of the sea-bottom.

It would be a matter of great scientific interest to have a bottom-sampler used down the slope of the continent at all depths, out on the very ocean floor, to determine all the communities living here, and to prove how barren the ocean floor really is. It would also be of great interest to follow our European communities from the North Pole down to Cape Town, to study their geographical distribution, to determine the perfectly unknown Arctic communities, and the unknown tropical communities. I have given a hypothetical chart in my Report No. 22, but it has to be verified. I am too old to do that, and my steamer too small. I hope other men will do it. I am sure the geologists would be glad to know something about these communities, based upon the common animals. I am certain that, like me, they care much more for common characteristic species and their distribution than for "rare" animals.

The productivity of the bottom fauna in European waters is by no means unlimited; it is, therefore, a matter of the greatest importance for some of the greatest fishery questions to know as much as possible about this productivity. The English fishermen are, as I often have heard, the backbone of the English navy; they depend upon the fishes, and these in turn depend upon the fish-food. Careful investigation of the latter is, therefore, a matter of great importance—particularly for Great Britain.

Adhesives.

By EMIL HATSCHEK.

THE treatise of Theophilus Presbyter, entitled "Diversarum Artium Schedula," and well known to all students of the history of painting, gives directions for the preparation and use of glues from leather and deers' antlers, of plum- and cherry-gums, and of mixtures of cheese and lime described as "cheese glues." This list of adhesives familiar to craftsmen at the end of the eleventh century covers practically all the types in use at the beginning of the twentieth century. A similar degree of old empirical perfection is shown by many arts employing colloidal material, and the student of colloid chemistry anxious to magnify his office is perpetually confronted with the task of explaining the *rationale* of traditional procedure and of suggesting improvements based on theoretical grounds.

The difficulties of this task are well illustrated by the first report of the Adhesives Research Committee.[1] Towards the end of the war a shortage of glue and of the chief substitute, casein, threatened to limit the output of aircraft, and the labours of the committee were accordingly directed, on one hand, to a close study of glue, and, on the other, to the discovery of possible substitutes other than casein. The report contains much interesting and novel matter under both heads.

The difficulties in the way of a rational study of glue seem to be twofold. The first is that the only criterion of its value as adhesive is a mechanical test of a glued joint between wooden test pieces of specified nature and size. The report describes the conditions of such a test, as finally adopted, and sets forth the possible sources of error. Both on theoretical and on practical grounds (about five days have to elapse from the soaking of the glue to the actual breaking test), it is desirable to find some easily measured constant which shows a simple quantitative relation with the breaking strength. No such constant is yet known, although empirically the setting time of the glue sol, the melting point of the gel and its "strength," *i.e.* roughly speaking, its modulus of elasticity, furnish some indication of its quality.

The second difficulty is of a more fundamental nature. It is known that pure gelatin is not a good

[1] Department of Scientific and Industrial Research. "First Report of the Adhesives Research Committee," pp. iv+129. Price 4s.

adhesive, so that the superiority of glue must be due, directly or indirectly, to the presence of other substances of which, so far, little is known. Investigations on this point are proceeding; in the meantime the committee have evolved a novel and highly promising test, that for "diffusible nitrogen." A gel of standard composition is immersed in a known volume of water, and after a fixed time the nitrogen content of the latter is determined by Kjeldahl's method. This is, of course, due to compounds of much lower molecular weight or aggregation than gelatin, and—apart from some exceptions—the amount of diffusible nitrogen is roughly inversely proportional to the tensile strength. While this result is of great interest, it can scarcely be said to simplify the problem stated above, namely, what factors cause the difference between pure gelatin and glue. Speaking, however, quite generally, we know of no connexion between constitution and adhesive properties; the striking fact is how sparingly the latter are distributed between a very few materials even among highly hydrated colloids.

Lack of space forbids detailed reference to the very interesting investigations on the extraction of gelatin from various raw materials, but the committee's successful attempt to find a strong vegetable adhesive must be mentioned. A protein was prepared from castor bean residues—which are poisonous and therefore useless as cattle food—and this protein forms a strong adhesive with calcium hydroxide and alkaline salts in various proportions. From the data given regarding the solubility of this protein, it appears to be related to casein, and the mechanical properties of the adhesive prepared from it are not much inferior to those of casein glues.

The report is supplemented by an appendix—which greatly exceeds in length the report itself—giving a "Descriptive Bibliography of Gelatin." This is a very complete, lucid, and impartial summary of the vast literature, in which no paper of any interest seems to have been overlooked. Those from English sources—though important—are remarkably few in number, and this state of things suggests questions which are none the less curious for being familiar. One is whether the development of a very promising discipline is going to be left to workers of other nations as completely as was (to take an unhackneyed instance) that of the theory of functions; the other, whether such cases of neglect arise from deep-seated national tastes or idiosyncrasies in research, or merely from inadequate opportunities for tuition and experimental work.

The Decomposition of Tungsten.

THE September issue of the Journal of the American Chemical Society contains an account of the preliminary experiments made by Drs. Wendt and Irion on the decomposition of tungsten at extreme temperatures, with the production of helium, a report of which appeared in the daily press, to which reference has already been made in NATURE (April 1, 1922, vol. 109, p. 418). The authors regret the exaggerated early report, given wide publicity by the press after its oral presentation, and emphasise the preliminary character of the work. They describe fully the apparatus used for attaining temperatures above 20,000° by passing heavy currents through metal wires, and state that when tungsten wires are exploded in a vacuum at such temperatures the spectrum of helium appears in the gases produced. When the explosion is conducted in carbon dioxide, 0·713 milligram of tungsten gave rise to 1·01 c.c. of gas not absorbed by potash solution. The authors remark that their method "includes factors, both of cause and of error, analogous to those operative in the voluminous and inconclusive controversy on the evolution of helium in various types of low pressure electrical discharge tubes, extending from 1905 to 1915."

The electrical apparatus provided for currents of 40 amperes at 100,000 volts during the brief period necessary to charge the condenser, which was then discharged through a tungsten wire 0·036 mm. diameter and 4 cm. long. The wires were stretched between heavy copper terminals in a special spherical glass bulb of 300 c.c. capacity, which was capable of withstanding momentarily an enormous outward pressure, and had a small discharge tube sealed on for examination of the spectrum of any gas produced. The wire was heated to well above 2000° for 15 hours in a high vacuum before the explosion was made, and the tube before explosion showed no spectrum or fluorescence when connected with a 50,000-volt coil. No dust, smoke, or solid residue was left after the explosion. Gas was present, which showed the faint presence of the strongest green line of mercury, probably from back diffusion of the pumps, and the only other line uniformly present and positively identified was the strong yellow line of helium. It would seem that both hydrogen and neon were absent. The absence of hydrogen is of interest, since the atomic weight of tungsten is exactly 46 times that of helium, and this element would therefore not be expected to give hydrogen on disruption of its atom.

The explosion in carbon dioxide seems to have been less conclusive, as the authors do not seem to have been quite sure of the absence of unabsorbable impurities. They point out that if the entire weight of 0·713 milligram of tungsten had been converted into helium, 4 c.c. of this gas should have been obtained. The much smaller volume found would point to the production of heavier gases. Altogether the work is of very great interest, although the authors emphasise the necessity of complete analysis of the gas obtained before anything conclusive can be stated. This chemical test is to be made in the continuation of the work.

The Belt of Political Change in Europe.

IN a paper contributed to Section E (Geography) of the British Association at Hull, Prof. J. F. Unstead commented on the striking fact that the new states of Europe, or those which have gained or regained independent existence during recent years, lie in a relatively narrow belt of country extending across the whole of Europe from the Arctic Sea in the north to the Mediterranean in the south. West of this belt changes have been slight, while east of it a final settlement has not been reached. Of this belt no part has been exempt from change. It contains about 100 millions of people or about one-fifth of the inhabitants of Europe, and covers about one-fifth of the total area of the continent. The new states have been formed mainly by the break-up of three great empires, the disintegration of which was one of the results of the world war.

Prof. Unstead pointed out that the belt of change is a region caught between east and west, marginal to each and influenced by each, and he showed how

this idea applies both to physical and human conditions. Western Europe, with inland seas and intricate structure and relief, provides varied resources, maritime, agricultural, and mineral. Into this region spread the civilisation of the Mediterranean region, and here communities found the physical conditions which enabled them to develop. Physical barriers and relatively small productive areas gave distinctiveness and led eventually to the growth of separate nationalities. These nations became self-governing and, broadly speaking, democratic.

Eastern Europe, on the other hand, is characterised by uniformity of structure and relief, with great belts of similar climatic conditions and natural vegetation extending through it into Asia and so facilitating human migrations and military movements, mainly east and west. From the human as well as the physical point of view this region was for many centuries an extension of Asia and had but a scanty population. The Slav languages became characteristic and the authority of the Czar dominated the greater part of the region. The Asiatic incursions which in earlier centuries swept across the eastern plains were as a rule checked when they reached the belt of change. Here they found varied conditions of life, but different from those to which they had been accustomed. Traditions and names of invading tribes have been preserved, differences of language remain, and not infrequently feelings of hostility and memories of conquest are rife. Sufficient time has not yet elapsed for a complete fusion of races in the several regions of the belt. The Asiatic elements still assert themselves: Finns, Ests, Magyars, Bulgars, and Turks stand out, contrasted in one way or another with Swedes, Germans, Slavs, Albanians, and Greeks of European descent. Moreover, two small Nordic groups, Letts and Lithuanians, have preserved their identity from early times and remain distinct from other Nordic people in language and nationality. On the other hand, the occurrence of minerals has led to the partial penetration of Western influences.

Prof. Unstead went on to show the diversity of religion and political conditions in this belt of change. The problem of minorities exists in one form or another throughout the belt, and is perhaps the greatest menace to future peace. The present political units are by no means self-sufficing, and their frontiers are frequently barriers to trade and hindrances to production. Furthermore, the attainment of political freedom has often been accompanied by a check to production, commerce, and prosperity.

University and Educational Intelligence.

ABERDEEN.—Applications are invited for the Blackwell Prize, value 30 guineas, for an essay on "The Sculptured and Inscribed Stones of the North-East and North of Scotland." The essays, bearing a motto and accompanied by a sealed envelope bearing the same motto and giving the name and address of the writer, must reach the secretary of the university on or before January 1 next.

CAMBRIDGE.—Mr. J. Walton, St. John's College, has been appointed junior demonstrator of botany. Mr. F. A. Potts, Trinity Hall, has been reappointed demonstrator of comparative anatomy. Dr. A. B. Appleton, Downing College, Mr. D. G. Reid, Trinity College, Mr. A. Hopkinson, Emmanuel College, and Mr. V. C. Pennell, Pembroke College, have been reappointed demonstrators in anatomy. Dr. Ff. Roberts, Clare College, Mr. T. R. Parsons, Sidney Sussex College, have been reappointed demonstrators in physiology. Mr. G. V. Carey, Clare College, has been appointed educational secretary to the Cambridge University Press.

A. J. Smith, Downing College, has been appointed University Frank Smart Student in Botany. The John Winbolt prize has been awarded to F. E. Smith, Sidney Sussex College.

LEEDS.—Mr. Lascelles Abercrombie, lecturer in poetry at Liverpool University, has been elected by the council of the University professor of English language and literature, in succession to Prof. Gordon, who was recently appointed to the Merton professorship of English literature at Oxford.

LONDON.—It was announced in NATURE of July 29, p. 166, that Mr. H. G. Wells had consented to offer himself as Parliamentary candidate for the University, at the invitation of the executive of the University Labour Party, upon the retirement of Sir Philip Magnus at the end of the present session of Parliament. At a general meeting of the party held on Friday, October 6, Mr. Wells was adopted as Parliamentary candidate as recommended by the executive.

IT is announced that Mr. H. M. McCreath, head of the Agricultural Department, Seale-Hayne College, Devon, has been elected principal of the East Anglian Institute of Agriculture, Chelmsford.

A SITE consisting of nearly 20 acres has been presented by Mr. T. R. Ferens at a cost of about 10,000*l*. to the education authorities of Hull for the immediate purpose of providing accommodation for advanced technical departments. It is anticipated that a university college will be developed later on the site.

THE distribution of geographical teaching in the universities of Europe is illustrated in a map which accompanies a paper by Mr. W. L. G. Joerg, in the *Geographical Review* for July, on "Recent Geographical Work in Europe." From this map it appears that more than 120 universities in Europe (excluding Russia and allied Soviet states) have provision for geography. Germany, Switzerland, and France are perhaps the best provided, but Great Britain does not fall far behind. In Balkan lands, geography is fairly well represented in Bulgaria and Yugo Slavia; Rumania has four universities offering geography, while Hungary and Czecho-Slovakia also have centres of instruction. On the whole, the new or reconstructed states of Europe show every indication of realising the importance of the subject. The only states in Europe which would appear to offer no university geography are Latvia, Lithuania, Albania, Greece, and Ireland.

DURHAM University has recently published a calendar for the year 1922–23 (price 3*s*. 6*d*. net), a useful compilation which serves as a guide to affairs in the University. The first half of the volume deals with the University as a whole; its officers, the regulations affecting conduct and degrees, as well as the subjects required for the latter and for various diplomas are given. A special section is devoted to the fellowships, scholarships, and prizes which are awarded by the University. The remainder of the calendar is divided into three sections referring to the Durham colleges, the College of Medicine, Newcastle-upon-Tyne, and Armstrong College, respectively. It should be noted that up to and including September 1923 the matriculation examination will continue to be held in Durham and Newcastle; after October 1923 the matriculation examination (Newcastle Division) will cease to be held. The new regulations for matriculation in the Newcastle colleges, which will then come into force, are given in detail. In a concluding section of the volume there is an alphabetical list of members of Durham University.

Calendar of Industrial Pioneers.

October 15, 1889. Sir Daniel Gooch died.—An eminent locomotive engineer and industrial administrator, Gooch served an apprenticeship in Stephenson's works at Newcastle, and at the age of twenty-one became locomotive superintendent to the Great Western Railway. He invented the Gooch link gear, experimented on the resistance of the atmosphere to trains in motion, designed a self-registering dynamometer, and built many fine broad-gauge engines. After resigning his position, he played an important part in the establishment of telegraphic communication between England and America, and from 1865 to 1887 was chairman of the Great Western Railway.

October 17, 1907. Gustav Adolf Zeuner died.—Born in Chemnitz, November 30, 1828, and educated at the Mining Academy at Freiberg, Zeuner as a professor of engineering did important work at Zurich, Freiburg, and Dresden, while his writings were highly valued by engineers. He founded the German journal *Zivilingenieur*, and he was widely known for his works on value gear and on technical thermodynamics.

October 18, 1903. Gordon McKay died.—The most successful inventor of boot-sewing machinery, McKay, who was born in Massachusetts in 1818, made an immense fortune which he bequeathed to Harvard University for science professorships and laboratories.

October 18, 1918. Marcel Deprez died.—For nearly forty years Deprez devoted himself to the application of electricity to industrial purposes. He solved many of the problems connected with the transmission of high-tension electricity, invented the compound winding for dynamos and devised measuring instruments. From 1890 he was professor of industrial electricity at the Conservatoire des Arts et Métiers.

October 19, 1749. William Ged died.—The inventor of stereotyping, Ged was born in 1690 and became a goldsmith in Edinburgh. In 1725 he took out a patent for developing Van de Mey's idea of substituting for movable type solid plates cast from type, and four years later he endeavoured without success to introduce his methods in London. His subsequent career was one of disappointment, and he died in poverty.

October 19, 1897. George Pullman died.—Pullman, to whom the world owes the modern railway carriage, was born in 1831 in New York State, and in 1859 settled at Chicago, where he began experimenting on the construction of sleeping-cars, his first successful car, the "Pioneer," being built in 1863 at a cost of 3000*l*.-4000*l*. The Pullman Palace Car Company was founded in 1867; extensive works were laid out in 1879, and at the time of Pullman's death more than 15,000 men were employed in them. The sleeping-car was introduced into England in 1875.

October 21, 1896. James Henry Greathead died.—Trained as a civil engineer under Barlow, Greathead devised the "Greathead" shield, which has since been extensively used for driving tunnels.

October 21, 1902. Sidney Howe Short died.—Regarded as one of the most brilliant electrical engineers of his day, Short was a native of Columbus, Ohio, where he was born, October 8, 1858. Educated at the Ohio State University, at the age of twenty he succeeded Mendenhall as professor of physics there, and two years afterwards removed to Denver, Colorado. Resigning his chair in 1885, he took up practical work and did pioneer work in connexion with electric railways.

E. C. S.

Societies and Academies.

SWANSEA.

Institute of Metals, September 22.—F. L. **Brady**: The structure of eutectics. An attempt has been made to correlate the micro-structure of solidified eutectics, mainly those between metals and metallic compounds, with the physical properties of the component metals. The surface tension of the molten metal and the cohesive force acting during crystallisation seem to be the main forces influencing the final structure. The eutectics examined fall into three classes: "globular," "lamellar," and "angular." The structures agree with what would be expected from theoretical considerations of the effects of surface tension and cohesion.—M. **Cook**: The antimony-bismuth system. The two metals form an isomorphous series of alloys. The liquidus curve is perfectly smooth and the solidus is horizontal at 270° C. up to 60 per cent. of antimony, after which it rises steeply to the freezing-point of antimony. Chill-cast and slowly cooled specimens reveal duplex structures, but with prolonged annealing—550 hours at 275° C.—the alloys become homogeneous. Twin crystals and peculiar banded effects were observed in some of the annealed specimens. Possibly the twin crystals are formed during solidification of the alloy by stresses due to expansion, and grew on annealing. The nature of the "bands" has not been definitely ascertained, though they are not considered to be slipbands.—A. **Jefferson**: The cause of red stains on silver-plated work. The Sheffield Silver Trade Technical Society appointed a committee to examine this subject. It was established experimentally that the red stain is caused by the indiscriminate use of rouge in the finishing and polishing processes, through the absorption of the rouge into the open pores of the heated surface, the heat being evolved by the friction of the hand or finishing "dolly."—Q. A. **Mansuri**: Intermetallic actions. The system thallium-arsenic. By thermal and microscopic analysis it was shown that thallium and arsenic do not act chemically with each other nor do they form solid solutions; they alloy in all proportions. Arsenic dissolves in molten thallium and lowers its freezing-point until a solution of 8·01 per cent. arsenic freezes at the eutectic temperature of 215° C. Then the freezing-points of the alloys rise gradually to 240° C. All alloys containing from 13 to about 40 per cent. arsenic begin to freeze at 240° C. and are made up of two layers—the upper layer rich in arsenic while the lower rich in thallium. Beyond 40 per cent. arsenic, to nearly pure arsenic, the solution is uniform and the two layers disappear. By heating such substances in evacuated, sealed glass tubes and applying the hot junction of the couple in close contact with the outside of the glass tube, the couple is almost as sensitive as when dipped in the molten substance.—F. **Johnson** and W. **Grantley Jones**: New forms of apparatus for determining the linear shrinkage and for bottom-pouring of cast metals and alloys, accompanied by data on the shrinkage and hardness of cast copper-zinc alloys. The shrinkage values of chill-cast copper-zinc alloys were higher in general than those obtained for sand-cast bars by previous investigators. Pure electrolytic metals were used, and most of the alloys were poured at a temperature interval of approximately 115° C. above their liquidi, the mould being kept at a constant temperature by a jacket of water maintained at the boiling-point. The bottom-pouring apparatus has the advantage of (*a*) control of pouring temperature; (*b*) facility for registering temperature of metal; (*c*) absence of delay between attainment of required pouring-temperature and release of metal into the

mould; (d) control of rate of pouring; (e) exclusion of dross from stream of metal; and (f) mitigation of "zinc-fume." Uniformity of hardness was secured by annealing. For the annealed bars the Brinell curve showed an increase of hardness over the range 100 to 88 per cent. copper. From 88 to 72 per cent. copper hardness was constant, a slight fall setting in at about 72 per cent. copper and persisting to 63 per cent., at which point a rapid increase set in with the appearance of the β-constituent. With the exception of a small dip in the curve, between 53 and 50 per cent. copper, the increase is maintained to 45 per cent. copper. The changes of scleroscopic hardness with composition are similar but less pronounced. The hardening capacity of the α-brasses under cold-work increases rapidly with increase of zinc up to a maximum near 75 per cent. copper. The rolled strips, after close annealing, were re-tested for hardness; the range of uniform hardness is slightly restricted and the succeeding fall (between 70 and 63 per cent. copper) is more pronounced.—F. W. **Harris**: The hardness of the brasses, and some experiments on its measurement by means of a strainless indentation. The theories generally advanced with regard to the connexion between hardness and internal constitution have been, in the main, substantiated. A slight maximum occurs in the middle of the α-phase and a small depression in the β-phase. The "absolute" hardness for the series was compared with the Brinell hardness by means of curves.

PARIS.

Academy of Sciences, September 11.—M. L. Maquenne in the chair.—L. **Cuénot** and L. **Mercier**: The loss of the faculty of flight in parasitic Diptera. The hypothesis generally admitted is that the atrophy of the wings is the result of non-usage connected with the parasitic mode of life. The authors give the results of a series of observations directly opposed to this view.—E. **Merlin**: A mobile space attached to a network.—P. **Urysohn**: Cantorian multiplicities. D. **Riabouchinski**: The equations of motion in two dimensions, of solids in a liquid with vortices.—Henri **Villat**: Plane vortex movements in a fluid containing solid walls.—M. **Thiébaut**: The composition of the iridescent marls. These marls contain three main constituents: carbonates (dolomite and calcite), a silicate which is not a clay, approaching celadonite and bravaisite in composition, and detritic elements with abundance of white mica and quartz.—W. J. **Vernadsky**: The problem of the decomposition of kaolin by organisms. In admixture with bacteria, diatoms developed well on a nutritive medium, containing no silica except combined silica in a colloidal clay. From these results it would appear that diatoms, either alone or in association with bacteria, can decompose the kaolin structure and set free alumina.—Cam. **de Bruyne**: Idioblasts and diaphragms in the Nymphaceæ.—Marc **Romieu**: A method of selective coloration of the nervous system in some invertebrates. Details of the application of the benzidine-hydrogen peroxide reagent to the study of the nervous system of some invertebrates. The nerves are coloured blue; and the nervous system as a whole can be seen down to the smallest details.—Gabriel **Bertrand** and M. **Mokragnatz**: The presence of cobalt and nickel in plants. The ashes from twenty species of plants have been analysed, the parts utilised as food being chosen for examination. Nickel has been found in all the plants examined in quantities between 0·01 milligram and 0·2 milligram per kilogram of fresh material: cobalt (0·005 to 0·3 milligram per kilogram) was found in all cases except oats and carrot.

Diary of Societies.

MONDAY, OCTOBER 16.

FARADAY SOCIETY AND THE BRITISH COLD STORAGE AND ICE ASSOCIATION (at Institution of Civil Engineers), at 2.30, 4.45, and 7.45.—Discussion on the Present Position of the Generation and Utilisation of Cold.—Prof. H. Kamerlingh Onnes and others: Laboratory Methods of Liquefaction, and Methods of Measuring Low Temperatures.—Dr. Crommelin: Description of the Equipment of the Cryogenic Laboratory at Leyden.—M. Claude: The Industrial Manufacture of Hydrogen by the Partial Liquefaction of Water Gas.—E. A. Griffiths and others.

CHEMICAL INDUSTRY CLUB (at 2 Whitehall Court), at 8.—Annual General Meeting.

ROYAL GEOGRAPHICAL SOCIETY AND THE ALPINE CLUB (at Central Hall, Westminster), at 8.30.—Gen. Bruce, Col. Strutt, Mr. Mallory, Capt. Finch, and Major Norton: The Mount Everest Expedition, 1922.

TUESDAY, OCTOBER 17.

ROYAL HORTICULTURAL SOCIETY, at 3.—R. G. Hutton: The Control of the Fruit Tree by its Roots.

ROYAL SOCIETY OF MEDICINE, at 5.—General Meeting of Fellows.

INSTITUTE OF TRANSPORT (at Institution of Electrical Engineers), at 5.30.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 8.—Major F. C. V. Laws: The Progress of Aerial Photography.

WEDNESDAY, OCTOBER 18.

ROYAL COLLEGE OF PHYSICIANS, at 4.—Dr. A. Chaplin: Harveian Oration.

INSTITUTE OF PHYSICS (at Institution of Electrical Engineers), at 6.—C. C. Paterson: The Physicist in Electrical Engineering (Lectures on "Physics in Industry," No. 3).

ROYAL MICROSCOPICAL SOCIETY, at 8.—Prof. R. Chambers: New Apparatus and Methods for the Dissection and Injection of Living Cells.—T. F. Connolly: The Specification of a Medical Microscope.—H. J. Denham: A Micrometric Slide Rule.

THURSDAY, OCTOBER 19.

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 4.30; at 8.30.—Dr. Savatard: Epithelioma of the Skin.

ROYAL AERONAUTICAL SOCIETY (at Royal United Service Institution), at 5.30.—J. D. North: The Metal Construction of Aeroplanes.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Dr. F. H. Hayward: Something Wrong with Intelligence Tests.

CHEMICAL SOCIETY, at 8.—Prof. T. M. Lowry: The Polarity of Double Bonds. An Extension of the Theories of Lapworth and Robinson.

SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (at Essex Hall), at 8.—Dr. Marie Stopes: The Ideals and Present Position of Constructive Birth Control (Presidential Address).

FRIDAY, OCTOBER 20.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Dr. H. S. Hele-Shaw: Presidential Address.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—G. H. Ayres: Profits from Waste Products.

INSTITUTION OF PRODUCTION ENGINEERS (at Royal Automobile Club), at 7.30.—M. R. Lawrence: Presidential Address.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 8.—G. A. Clarke: Record Work in Cloud Photography.

PUBLIC LECTURES.

SATURDAY, OCTOBER 14.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. Shaw: Flight in all Ages.

MONDAY, October 16.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. Shattock: The Anatomical Results of Inflammation.

CITY OF LONDON Y.M.C.A. (186 Aldersgate Street), at 6.—Dr. E. L. Ash: Mind and Health.

TUESDAY, OCTOBER 17.

GRESHAM COLLEGE (Basinghall Street), at 6.—A. R. Hinks: Astronomy. Succeeding Lectures on October 18, 19, 20.

WEDNESDAY, OCTOBER 18.

SCHOOL OF ORIENTAL STUDIES, at 5.—J. W. Robertson Scott: Impressions of the Japanese.

UNIVERSITY COLLEGE, at 5.30.—Sir Richard Paget, Bart.: The Nature and Reproduction of Speech Sounds.

THURSDAY, OCTOBER 19.

UNIVERSITY COLLEGE, at 4.—Dr. T. G. Pinches: Babel and its Gods.

CITY OF LONDON Y.M.C.A. (186 Aldersgate Street), at 6.—Sir D'Arcy Power: Surgery in the City of London.

FRIDAY, OCTOBER 20.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Hydrocephaly.

BEDFORD COLLEGE FOR WOMEN, at 5.30.—F. H. Marshall: The Early Civilisation of Ionia.

SATURDAY, OCTOBER 21.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: The Nile in the Life and Religion of the Ancient Egyptians.

SATURDAY, OCTOBER 21, 1922.

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Sex Economics.

IN his presidential address to the Section of Economics of the British Association at the recent meeting at Hull, Prof. F. Y. Edgeworth did not hesitate to plunge into the midst of a raging current controversy. "Should men and women receive equal pay for equal work?" were his opening words, and his conclusion is that they should "with some reservations and adjustments."

This conclusion is reached in two stages as follows. In a first approximation Prof. Edgeworth relegates dependants to limbo, and shows—we think conclusively—that, granted that freedom of competition for jobs is generally conducive to the best possible distribution of labour, then there is no reason why such competition should be confined to one sex; though it must be a regulated competition, controlled by collective bargaining, in which "the oppressive action of male Trade Unions" is "counteracted by pressure on the part of women acting in concert." The overcrowding of women into those occupations which are open to them, which has resulted from restrictions upon their freedom to compete on equal terms with men in all spheres, is in fact socially uneconomic as well as unfortunate in its effect upon the women's own wages. Prof. Edgeworth goes on to surmise that given substantial freedom of competition we shall find (*a*) occupations almost wholly male, (*b*) occupations into which both men and women enter freely, and (*c*) occupations almost wholly female. He submits that the average of weekly earnings in (*a*) will continue to be above the average of weekly earnings in (*c*), while in (*b*), though the rate of pay for a unit of work will be the same for both sexes, the average weekly earnings of the male will continue to be above the average weekly earnings of the female.

Prof. Edgeworth does not offer any particular evidence of these suggestions, which rest upon an assumption that at present, or rather "for a short period in the immediate future," the industrial efficiency of women must be generally inferior to that of men. In point of fact, practically no scientific investigation has yet been made of the relative efficiency of men and women in different occupations. Nor, in view of the close and long-standing restrictions upon the field of women's labour, does the actual distribution of the sexes between different occupations throw much light upon the problem. In quoting the usual examples of telephony, typewriting, textiles, and nursery duties as the female *fortes*, Prof. Edgeworth seems to be allowing convention rather than science to be his guide.

Wise advocates of women's rights will, however,

agree with Prof. Edgeworth when he points out where other things are equal an employer is likely to have a preference for the male owing to the "secondary" drawbacks of the female. Prejudice and restricted opportunities may be responsible for what truth there is in the charge that "a woman is not so useful in the case of a breakdown or a runaway." But it is quite indisputable that the probability of her early marriage is a real drawback to a woman's industrial efficiency. These secondary differences, however, are so difficult to measure accurately that the reduction on their account of the woman's rate per unit of work below that of the man is not a wise or scientific policy. It is better to allow them to make their influence felt upon the occupational distribution of the sexes rather than upon their pay. Of the "tertiary" differences also (of which the illustration given is "the presence and influence of a master—as contrasted with a mistress—in dealing with the bigger boys") the same is true; but there is no evidence to show whether these tertiary differences predominantly favour the male rather than the female.

We now restore the abstracted circumstances of family life. A man normally has, or expects to have, a family to support; a woman normally has not. While the average number of dependants supported by a woman from her earnings has often been greatly underestimated, there is certainly no disputing the general result of Messrs. Rowntree and Stuart's figures, which show that this average is much higher for a man than for a woman. The candid will admit that here is the real obstacle to equal pay for equal work; the logical will consider the possibilities of endowment of motherhood as a way out of the difficulty. Prof. Edgeworth summarises the *pros* and *cons* of State endowment of motherhood as follows. The proposal is attractive because (1) it would for the first time make competition between the sexes both free and fair; and (2) it would make possible the distribution of resources in such a way as to meet the requirements of the larger family better than is done at present, when the wage paid to a man tends to be adjusted to the presumption that he maintains a family of approximately 4·4 persons, which he quite certainly does not. Against these advantages Prof. Edgeworth sets the following: (1) the scheme is socialistic and bureaucratic, (2) it would almost certainly involve a transference of resources from the rich to the poor and would therefore probably check saving, (3) the effect on the contributor would be "depressing," and there would be (4) a great stimulus to population, and (5) no security for the improvement of the race, but only a prospect of "the ruin of the great middle class to which England owes so much."

We gather that Prof. Edgeworth regards these disadvantages as conclusive. He turns from the State endowment of motherhood to consider one or two other suggestions, the principal of which is his own proposal that the members of Trade Unions might themselves contribute a quota of their earnings to a fund to be distributed among the wives of members in accordance with the size of their families. In regard to this proposal Prof. Edgeworth does not commit himself beyond the canny statement that it would be much less open to objections than the endowment of motherhood by the State.

Prof. Edgeworth's address is open to little criticism from those who grant his premises. All will applaud his careful analysis of his subject. It is, however, at least open to question whether his whole treatment of the matter does not suffer immensely from the limitations which he has imposed upon himself. In his first approximation the assumption that "regulated competition" (a very vague concept) is a royal road to ideal distribution is open to serious criticism. Secondly, any discussion of endowment of motherhood which assumes outright that (*a*) transferences of resources from rich to poor would be entailed, and that (*b*) these are objectionable, rests on questionable ground. To the present writer this double assumption appears fatal to Prof. Edgeworth's conclusions regarding the right relation of the basis of payment to family circumstances. BARBARA WOOTTON.

Fishing and Fishing Lore.

Fishing from the Earliest Times. By W. Radcliffe. Pp. xvii+478. (London: J. Murray, 1921.) 28*s*. net.

THE literature connected with fishing is already so extensive that a new volume is liable to be subjected to scrutiny to see whether it can justify its birth by furnishing new matter or new ideas. As the more obvious gaps in the literature of the subject become fewer, the tests will necessarily become more searching. Mr. Radcliffe's book, fortunately, can claim a definite *raison d'être*, and may receive an enthusiastic welcome as filling a decided gap, one which it is curious should have so long remained void. His aim has been to provide a history of the fishing art and craft from the earliest times down to about A.D. 500. The title scarcely does justice to the contents of this versatile volume, which is far from being restricted to the consideration of actual fishing practices. These, indeed, probably occupy but a third of the book. The remainder is very largely concerned with what may be classed as the folk-lore associated with fish, fishing, fishermen, and fish-consumers, and with other details

which are by-products of the industry. Mr. Radcliffe has been at great pains to bring together a great mass of material which he has collated and coaxed into a very readable form. The illustrations are both good and numerous. The result is an important work which is both entertaining reading, and of considerable value as a comprehensive book of reference. In the main, it consists of classified quotations which are analysed and evaluated by the author. One would gather that the author has thoroughly enjoyed his self-imposed task. He revels in argument, and while now and then he may, perhaps, be suspected of "special pleading," his interpretations of doubtful or obscure passages are always interesting and suggestive, even when he fails to be entirely convincing.

The introduction extends over sixty pages and deals with a number of points of general interest and with early prehistoric fishing. For our knowledge of fishing practices during the Stone and Bronze Ages we are dependent upon evidence which is, unfortunately, meagre in amount, and requires much speculation for the completion of the picture. Mr. Radcliffe has not made an intensive study of fishing as practised by *recent* Stone-age peoples, and he makes but slight use of the evidence which they can afford, valuable though it may be for the light which it can throw upon the archæological record. Ethnological data must be brought to bear upon archæological research if an adequate diagnosis of early customs and appliances is to be achieved. A comprehensive work dealing with fishing pursuits and methods among the recent "unrisen" peoples, the progress of whose more or less primitive culture has been arrested or retarded at various stages of advancement, still remains to be written. When such a work, based upon comparative study, is available, archæological commentarists will find a valuable ally which will assist materially in their interpretations of ancient data.

The present volume would have gained by a wider reference to evidence derived from ethnological sources, and some of the problems with which Mr. Radcliffe deals so interestingly might have been more convincingly attacked or solved. Mr. Radcliffe takes especial delight in tracing the earliest references to various fishing-appliances. [See Figs. 1 and 2 here reproduced by the courtesy of the publishers.] To Martial he assigns the first mention of the jointed rod (*crescens harundo*), and of fishing with a fly; but to Ælian the first definite reference to the use of an *artificial* fly. In dealing with the latter, he appears to be convinced that the artificial fly of those days was an imitation, as close as possible, of a *natural* fly; but this view does not seem to be borne out by Ælian's description, which rather suggests the reverse, *i.e.* a type of lure which was a novelty to the fish, which were attracted by its unusual gaudiness. Aristotle is given credit as the first "scale-reader" in estimating the age of fishes. There seems to be a zoological confusion when Mr. Radcliffe uses evidence from two passages, one of which refers to the *scales* of fish which afforded an indication of age, while the other relates to the growth indications upon the *shell* of a Murex (a mollusc). But zoological differentiation is scarcely Mr. Radcliffe's strong point, and he apparently is convinced that dolphins are to be classed with the fishes (pp. 91, 92, 95, 165, 450, etc.), and this in spite of the fact that Aristotle, whom he quotes, recognised essential differences between fish and cetacean mammals. The plate opposite p. 180 is described as illustrating a "pattern of Torpedo fish"; but the three fishes represented clearly belong to three distinct varieties, all of them *bony* fishes, whereas the Torpedo fish (a kind of ray) belongs to the group of *cartilaginous* fishes. Again, on p. 414, he includes shell-fish among the fishes prohibited by Moses, without any covering comment. These "termino-zoological inexactitudes" tend somewhat to obscure the scientific status of the book.

FIG. 1.—The earliest representation of angling, *c.* 2000 B.C. From "Fishing from the Earliest Times."

A time-honoured controversy is revived and reviewed in detail in chapter 2, where the author deals with the various interpretations of the function of the ox-horn (κέρας βοὸς ἀγραύλοιο) referred to in the "Odyssey"

(xii. 251 ff.) and "Iliad" (xxiv. 80 ff.) in connexion with similes derived from fishing processes. The very varied theories are quoted and evaluated with skill, and the author himself inclines toward the suggestion of C. E. Haskins, namely, that the κέρας was an artificial bait of horn. This controversy has been carried on in the pages of the *Times* Literary Supplement, in reviews of the book, and in letters arising therefrom. The whole discussion, however, leaves one unconvinced and still wondering. Since the controversy still remains "fluid," I am tempted to offer yet another possible solution, to take its chance with those previously offered. Line-fishers on the coast of Western Ireland employ a very simple and ingenious contrivance to overcome the difficulty which arises from their hooks becoming entangled in seaweed, when fishing is pursued in rock-studded waters. It is desired to sink the baited hook below the level of the weed layer, and the problem is to pass it through the tangled and entangling mass. To achieve this, at a short distance above the hook there is attached to the line a crab's claw, which serves as a stop. Still farther up the line a weight (or sinker) of lead or stone is fastened, and between the stop and the weight an empty carapace of a crab is loosely threaded upon the line, so that it can slide along the latter between the sinker and the stop. When the line is cast out by the fisherman, the weight descends first, dragging after it the line; the water-resistance causes the bell-like carapace to slip along the line as far as the stop, so that it covers and protects the baited hook as it is carried downward through the weed stratum. Since the carapace is very light it probably floats away from and uncovers the bait when the line becomes stationary at the desired depth. Similarly, as the line is drawn in the resistance of the water drives the bell down over the hook and again protects it on the upward journey. Now, substitute a selected bell-shaped ox-horn for the crab's carapace and a slightly more efficient form of this apparatus is devised, which should serve the same purpose admirably.

FIG. 2.—The happy fisherman, attributed to the artist Chachrylion. From "Fishing from the Earliest Times."

The merit, if any, of my suggestion is derived from the following facts, (1) that the apparatus which affords a seeming clue to the function of the κέρας is an actual one still in practical use locally, and is very possibly a survival from an ancient type formerly far more widely employed; (2) that the much-debated "resounding splash" (cf. στονάχησε δὲ λίμνη in the Iliad passage) is plausible as a description of the effect produced by casting such an apparatus into the sea; (3) that it is consistent with fishing from a headland on a rocky and weedy coast such as, I believe, is characteristic of southern Italy and of the region lying between Samos and Imbros, the areas to which Homer's two similes are applied; (4) that it conforms with the picturesque description of the dive of Iris when she "sped to the bottom like a weight of lead, that mounted on the horn of a field-ox goeth down, bearing death to the ravening fishes"; (5) that the κέρας βοὸς ἀγραύλοιο which some commentators aver must imply the *whole* horn, and not merely an object made of horn, would, for the purpose I have suggested, have been practically entire, so that the hook could be withdrawn into its protecting cavity. A small hole drilled in the apex (through which to pass the line) would be the only essential modification required. The expression "mounted *on* the horn" alone offers some difficulty; "near" or "with" instead of "on" would certainly have added weight to my suggestion.

The problems suggested by or dealt with in this book are numerous, and Greek, Roman, Egyptian, Assyrian, Jewish, and Chinese fishing methods and fishing lore

all receive detailed and careful treatment. The author has brought to bear upon his task the experience of a practical and enthusiastic angler, and the zest of a keen student. While he realises the more serious aspects of his theme, he has dealt kindly by the general reader and writes in a light-hearted, attractive, and unpedantic manner. In this way he should be instrumental in developing a wider interest in and stimulating further research into the history of one of the oldest industries, and has given us the story of progress from a humble and despised craft to a popular and respected art. HENRY BALFOUR.

The Metallurgy of Iron and Steel.

(1) *Engineering Steels.* By Dr. L. Aitchison. (Reconstructive Technical Series.) Pp. xxxi + 348 + 48 plates. (London: Macdonald and Evans, 1921.) 25s. net.

(2) *The Case-Hardening of Steel: An Illustrated Exposition of the Changes in Structure and Properties induced in Steels by Cementation and Allied Processes.* By H. Brearley. Second edition. Pp. xi + 207. (London: Longmans, Green and Co., 1921.) 16s. net.

(3) *Iron-Founding.* By B. Whiteley. (Pitman's Common Commodities and Industries.) Pp. 131. (London: Sir I. Pitman and Sons, Ltd., 1921.) 3s. net.

(1) THE advance of metallurgy in recent years has placed at the disposal of the engineer a wide range of new materials, including alloy steels which so far surpass the older, plain carbon steels in strength and toughness as to constitute a new class of metals. In the face of such diversity the engineer finds difficulty in selecting the most suitable material for a given purpose, and is not in a position to judge between the products offered by manufacturers, or recommended by specialists. There are in existence many excellent memoirs and a few books on the subject, but they are written for the metallurgist, and assume a technical knowledge that lies outside the usual field of study of the engineer. It is highly desirable that the user of a metal should understand its properties as well as the maker, and Dr. Aitchison has made the attempt, largely successful, to describe the steels now available for engineering purposes, without assuming a knowledge of chemistry or metallurgy.

The title of Dr. Aitchison's book must be interpreted in a rather restricted sense. The engineer is interested in such steels as those used for ship and boiler plates, rails, and girders, but he will find little in reference to them, the work being mainly concerned with steels required by the automobile and aircraft industries. It is these steels of high tensile strength, often required to withstand severe alternating stresses, that present the greatest difficulties of specification and testing, and it is very necessary that the information regarding them should be collected and placed clearly before the engineering user, as has been done here. There is a very brief account of methods of manufacture, sufficing to indicate the distinction between various classes of steel, and a discussion of ingot structure, so far as is required to explain the possible sources of defects in forgings.

It is probably on account of the limitation mentioned above that only piping steel is described, and the subject of blowholes is not mentioned. Steel castings are omitted entirely, although of great interest to the engineer who uses high tensile steel forgings for other parts of his machine. The desire to avoid chemical and metallurgical difficulties leads to a somewhat excessive simplification of the chapter on heat treatment, and the author's account of hardening and his explanation of the critical points is rather misleading, although not likely to cause misunderstanding of the practical instructions. It should be said that the style is easy and readable throughout.

The subject of mechanical testing is well treated, proper attention being given to the determination of the fatigue range and its relation to the other measurements usually made in the testing laboratory. Much of the experimental material in this chapter is taken from the author's reports to the Aeronautical Research Committee. His conclusions may not always be accepted, but the importance of the subject is rightly emphasised, and the descriptions of fatigue tests and the short accounts of other special methods of testing are valuable. There are very few references to original sources, but a full bibliography of papers relating to the determination of hardness is given.

The alloy steels are considered in detail, the properties of each steel, as modified by different heat treatments, being shown by means of diagrams similar to those published by the Automobile Steel Research Committee; these diagrams provide a useful guide to the characteristics of the various classes of steels. Case-hardening and cold-working are other subjects dealt with.

The book is very well printed and illustrated, many of the best plates being selected from Mr. Brearley's works, while others show special types of testing machines. The whole subject of the relative value of tests for steels of this class is in a state of flux, and an authoritative statement is not yet to be expected, but Dr. Aitchison has made a good beginning, and his efforts will be welcomed by engineers.

(2) The first edition of Mr. Brearley's book on case-hardening was published in 1914, and it is an indication

of its trustworthy character that scarcely any statement contained in it has had to be withdrawn in the preparation of the new edition. The subject-matter has been widened by the inclusion of further particulars concerning alloy steels of the class frequently employed in automobile construction, and by the addition of sections on specifications, in regard to which the author expresses decided opinions, based on a wide experience. The treatise is of more general interest to the metallurgist than might be assumed from its title, since the description of the materials and processes of case-hardening and of the defects that may occur in case-hardened objects, involves the discussion of many other points of importance in the treatment and use of steel. On all these subjects, the advice given is sound and admirably clear in its expression. Only two minor points have been noted for criticism. There is no mention of nichrome carburising boxes, although these are now frequently used, and justify by their long life the increased cost. Plating with copper, as a means of local protection against carburisation, is still spoken of as unsatisfactory, although it has been practised with great success in the construction of aero-engine parts.

(3) The third work on our list is an elementary handbook on iron-founding. It contains a simple description of foundry methods, and the illustrations include a series of photographs of the mould for a gas-engine cylinder at various stages. Moulding is considered much more fully than melting, and the book is well adapted to give a general idea of the processes used in preparing moulds, and of the organisation of a foundry. The theoretical side is weak, and some very erroneous statements as to fuel and thermochemistry would have been better omitted. The printing and illustrations are good.

C. H. DESCH.

The Snakes of Ceylon.

Ophidia Toprobanica, or The Snakes of Ceylon. By Col. Frank Wall. Pp. xxii+581+1 map. (Colombo: Colombo Museum, 1921.)

A GOOD deal has been written on the subject of the snakes of Ceylon. Thus Günther's "Reptiles of British India" (1864), and Boulenger's "Fauna of British India—Reptiles and Batrachians" (1890), both include descriptions, and in the case of the former work, remarks on the habits of many of the snakes inhabiting Ceylon. There is also the "Snakes of Ceylon" by Abercromby, a small popular treatise which appeared in 1910. Except for the last-named work, which is very incomplete, there is, however, no book which deals solely with the snakes of Ceylon, apart from those inhabiting India, and Col. Wall, an enthusiastic naturalist and specialist on Indian snakes, in producing the volume under review has succeeded in filling a long-felt want.

The author in his work gives an account of the marine snakes which may be met with around the shores, as well as the terrestrial forms. A full description is given of every snake, and the determination of the genera and species is often facilitated by useful, if somewhat unscientific, keys. Except when dealing with the sea-snakes, Col. Wall has in most cases adopted the nomenclature used in Boulenger's Catalogue of the British Museum. Sometimes the generic and specific names have been altered. It is impossible without going thoroughly into the various contested points to say whether the author is in every case justified in departing from Boulenger's classification, although he occasionally appears to have good reasons for so doing. We are not, however, always inspired with confidence in Col. Wall's judgment. Thus "until I am satisfied of their specific unity I prefer to regard them as distinct species" is the dogmatic reason he gives when advocating specific distinction for certain forms of Kraits, held by Boulenger, in spite of their distinctive coloration, to be only geographical varieties of the same species.

A feature of the book is the very full account given of the habits of the snakes. The author has had practical experience of the reptiles in their native haunts, and his descriptions of their feeding and breeding habits add greatly to the value of the work. There are also some interesting remarks on the subject of distribution. Many snakes inhabiting upland regions have a very restricted habitat, neither ascending nor descending beyond certain limits. The elevated ranges and peaks, where the lower slopes merge into the low country, are just as effectually isolated as if they were surrounded by the sea.

Much space is devoted to the subject of snake-bite, for the benefit of the medical practitioner, and a number of illustrative cases from the records of various doctors are given.

E. G. B.

Japanese Social and Economic Life.

The Foundations of Japan: Notes made during Journeys of 6000 Miles in the Rural Districts as a Basis for a Sounder Knowledge of the Japanese People. By J. W. Robertson Scott. Pp. xxv+446+plates. (London: J. Murray, 1922.) 24*s*. net.

THIS is an eminently readable book, giving not only the familiar glimpses into superficial Japanese life, but also treating of the economic life of

the nation in a really profound manner. The author spent four and a half years travelling through the country, studying the habits and thoughts of the men and women of the countryside, who were trained under rural schoolmasters and village elders and are living their life under the potent sway of long-established tradition. The modern industrial developments of factory life are also depicted with a sure hand, and where there is much to praise there is also much to condemn. For example, the conditions under which silk-factory girls work are little short of slavery, and would be impossible in English-speaking countries. On these and other deeper aspects of Japanese life the author evidently speaks with knowledge. With real sympathy and honesty he describes the present-day sociological conditions which rule among the great majority of Japanese. As he himself says, he went to Japan to see the countrymen.

"The Japanese whom most of the world knows are townified, sometimes Americanised or Europeanised, and, as often as not, elaborately educated. They are frequently remarkable men. They stand for a great deal in modern Japan. But their untownified countrymen . . . What is their health of mind and body? By what social and moral principles are they swayed? To what extent are they adequate to the demand that is made and is likely to be made upon them?"

Such are some of the questions which Mr. Scott sets himself to answer. This he does by describing his wanderings in various provinces, touching upon all kinds of Japanese customs as they come before him. The result is in many cases a curious mosaic of random thoughts, greatly satisfying to one who has lived in Japan, but probably not a little confusing to one who has never been there and is reading for enlightenment. In other chapters, however, there is a sustained and serious discussion of some broad aspect of Japanese life. In all cases the author writes with a freshness and accuracy which bespeak a full knowledge and a discriminating judgment.

Dealing as it does with the facts at the basis of human life, the book is aptly called the "Foundations of Japan." From this point of view the book is a real addition to ethnological literature, and is worthy of commendation in the pages of NATURE. For the more serious student of industrial economy there are some interesting appendices with instructive statistics; and well-chosen drawings and photographs elucidate many of the questions discussed. Among the subjects treated at considerable length are the cultivation of rice, the whole process of sericulture, the problem of labour, and the education of boys and girls. In conclusion it may be said that Mr. Scott has the gift of a true teller of stories, many of which show forth in a graphic way some characteristic traits of our Eastern Allies.

Hull and the East Riding.

Handbook to Hull and the East Riding of Yorkshire: Prepared for the Members of the British Association for the Advancement of Science on the Occasion of their Visit to Hull, in September 1922. Edited by T. Sheppard. Pp. viii + 532. (London and Hull: A. Brown and Sons, Ltd., 1922.) 5*s*.

THE ideal handbook in connexion with the annual visits of the British Association has yet to be written, but it would be unfair if we withheld the full meed to the editor and sub-committee who have produced this interesting publication. It approaches nearer to our ideal than that issued at any previous meeting; so far as possible technicalities have been avoided, for the work is not intended for the expert, who already knows the special works and articles relating to the different subjects treated of. It is essentially a guide for the average member who wishes to learn something of the history, archæology, antiquities, folk-lore, geology, natural history, and economics of the town and district in which the parliament of science has recently been held.

After a brief account of the evolution and growth of Hull, we pass on to short accounts of its past history and antiquity, its rise and progress, places of interest, Hull coins and tokens, its charters, etc. The various prehistoric remains of East Yorkshire are briefly described and illustrated, and interesting chapters are devoted to the Romans, Anglo-Saxons, and Danes in this division of the county. The Rev. Canon A. N. Cooper contributes a well-illustrated chapter on East Riding churches, and Mr. John Nicholson one on East Riding place-names. There are further sections treating of the charities, engineering and shipbuilding, education, agriculture in the East Riding, while the geology and lost towns of the Humber receive very full treatment at the hands of the editor.

Nearly three hundred pages are devoted to the description of the fauna and flora, and in spite of the fact that some of the writers have not been able to depart from the useless local list method of treatment, the various contributors have handled their sections most ably. An outstanding feature is Mr. John W. Taylor's excellent account of the land and freshwater mollusca. The weakest section is undoubtedly that on the crustacea, which is unfortunate, as much good work has been done on the non-marine forms.

Apart from its value and usefulness to the visitor to Hull, this work will fulfil a double service if it serves

to show the citizens of Hull the many points of interest their city possesses, and of which they are the trustees.

The wealth of illustrations considerably adds to the interest of this work. Future compilers of the British Association local handbook will do well to study carefully the Hull model. W. E. C.

Our Bookshelf.

The Biology of the Seashore. By F. W. Flattely and C. L. Walton. Pp. xvi + 336 + 16 plates. (London: Sidgwick and Jackson, Ltd., 1922.) 16*s.* net.

THE study of zoology from the ecological standpoint has made rapid strides in America under the energetic leadership of Dr. Adams and Dr. Shelford, and there has been a steady output of text-books and popular books on Nature study written from this point of view. In this country, zoological ecology has received very little attention, and we welcome, therefore, if only on these grounds, this excellent work on the biology of the seashore. As the authors point out, their book is not intended to supersede but to supplement previous works which have been written on classificatory and morphological lines. In fact, they demand a previous knowledge of classification and external morphology in those who use their work. Given this the authors have directed special attention to functional biology and to the adaptations which organisms present to marine life in all its phases.

The book is an exhaustive summary of the known facts of marine biology from the ecological point of view, and reveals a wide knowledge of the literature of the subject. The illustrations are good and adequate, and the advice given on the methods of ecological research should be most useful to students. The authors, however, have not been content merely to summarise known facts. The book bristles with suggestions for research and further inquiry, and in this respect is most stimulating. It should be in the hands of all students of marine biology. With its help more real knowledge of life in the sea will be obtained than from any other text-book we know. It is not enough to know the mere population of the sea; some knowledge of the laws governing life there, and of the actions and interactions of organism and environment is vastly more interesting and stimulating, and the work under notice supplies the right kind of guidance in this inspiring field of study.

Catalogue of the Books, Manuscripts, Maps, and Drawings in the British Museum (Natural History). Vol. 6. Supplement: A-I. Pp. iv + 511 + 48. (London: British Museum (Natural History), 1922.) 2*l.* 15*s.*

THE Library of the British Museum of Natural History is probably one of the most complete, and certainly one of the most important, libraries of works on natural history in the world. The publication of a catalogue of its contents has been of immense service to scientific workers, who find in it a valuable guide to the literature of their subject and a wealth of bibliographical detail which is of the greatest value in settling vexed questions of priority and ensuring accuracy of reference. The first half of the supplement to the main catalogue has now been issued and serves to give some idea of the natural growth of this splendid library. Like the preceding volumes, it has been prepared by Mr. B. B. Woodward with the same meticulous care and accuracy, and includes as before the results of much bibliographical research by the author and Mr. C. D. Sherborn. The 48 pages of "Addenda and Corrigenda" to the main catalogue consist almost entirely of additional bibliographical information which has accumulated since the catalogue was published.

The expenditure of public money on the publication of a catalogue of this kind is more than justified by its extreme value and usefulness, though it is a pity that so valuable a work as this supplement should have been sent out in a paper cover. For its own value and for the sake of uniformity it is worth a binding similar to its predecessors. Scientific workers are grateful to Mr. Woodward and to the trustees of the British Museum for having made the resources of their library known in this readily accessible form.

Obras completas y correspondencia cientifica de Florentino Ameghino. Volumen 3. La Antigüedad del Hombre en el Plata. Dirigida por Alfredo J. Torcelli. Pp. 821. (La Plata: Taller de Impresiones Oficiales, 1915.) n.p.

THE third volume of the handsome collected edition of the late Florentino Ameghino's geological and palæontological works now being issued by the government of the province of Buenos Aires, is a reprint of his treatise on the antiquity of man in La Plata originally published in 1880. Francisco Moreno had then just founded the Anthropological and Archæological Museum at Buenos Aires (afterwards removed to La Plata), and Ameghino himself was studying with Henri Gervais in Paris, where he exhibited part of his collection at the Universal Exposition. The author was thus well furnished with materials, and had unusual opportunities of making himself acquainted with the latest advances in the subject of the antiquity of man. While describing the results of his own researches, he therefore took the opportunity of making many references to European and North American work which were illuminating. His volume is a most exhaustive discussion of the remains of the handiwork of prehistoric man discovered in Argentina, illustrated by twenty-five large plates. Of the skeleton of man himself no important fragments had at that time been found. The geological observations are particularly valuable and interesting, and Ameghino seems to make it quite clear for the first time that the man of the pampas was a contemporary of the extinct glyptodonts or giant armadillos, and actually used their large bony carapaces as roofs for his lowly habitations. Although naturally out-of-date, the whole treatise is a valuable record of facts and observations, in which the reprint will stimulate renewed interest. A. S. W.

Le Pôle Sud: Histoire des voyages antarctiques. Par J. Rouch. Pp. 249. (Paris: Ernest Flammarion, 1921.) 7 francs net.

M. ROUCH was one of the officers of the *Pourquoi Pas?* in Dr. Charcot's second Antarctic expedition, and familiarity with the conditions of navigation and the privations of wintering in the Far South has given him

a great advantage in dealing with the history of exploration in the South Polar regions. With the space at his disposal no one could have done better than M. Rouch in setting forth with equal detail all the outstanding Antarctic voyages from that of Cook in the *Resolution* to that of Shackleton in the *Endurance*. Except for a very few slips in the spelling of names (*Thun* instead of *Chun* on the *Valdivia* is the only serious one) the accuracy of the work is quite remarkable, and the facts regarding the various expeditions have obviously been selected from the original narratives.

The style is lively and sympathetic but concise and sailorly. M. Rouch holds all explorers as his brothers and there is a delightful air of *cameraderie* in his treatment of the aspirations and achievements of British, French, Russian, American, Swedish, Norwegian, and German explorers. It is refreshing to find this fine French sailor giving credit impartially to his German rivals and his French colleagues, and with an almost British self-criticism touching more frankly on the little shortcomings of his fellow-countrymen than on those of foreigners.

Perhaps the author's imagination has assisted a little in describing the details of Scott's last expedition; but if he here allows dramatic truth to prevail over verbal accuracy it is in excess of sympathy.

The numerous illustrations are excellent as showing Antarctic conditions, but they obviously refer only to the author's own section of the region. H. R. M.

Mineral Land Surveying. By Dr. J. Underhill. Third edition, revised. Pp. viii+237+3 plates. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1922.) 17*s.* 6*d.* net.

DR. UNDERHILL'S book describes the methods in use for the survey of the mineral lands in the western portion of the United States. It should certainly be in the possession of all surveyors who intend to proceed there; but only the first three chapters are likely to be of much service to mine surveyors in England. In chapter 1, on direct solar observation, the method of obtaining the true meridian by single observations on the sun is clearly and fully explained, with the aid of several worked examples, after the derivation of the formula employed has been given. The method of obtaining latitude by solar observation is also briefly described. Chapter 2 describes the Shattuck Solar Attachment, the Burt Solar Attachment, and the Berger and Saegmuller Solars and their use for finding true meridian and latitude. Of these, the Shattuck Solar Attachment appears to find most favour with the author, who states that he has obtained perfect checks on this instrument by direct observation of the sun. Chapter 3 is a useful account of traversing and measurements, including stadia measurements. Other chapters deal with location surveys, including calculation of areas by the double meridian distance method, patent surveys, patent field notes, Land Office and Records, and the examination for commissions as United States Mineral Surveyor with typical questions and solutions. The appendix includes extracts from the Manual of Instructions for the Survey of the Mineral Lands of the United States.

L'Océanographie. Par Prof. J. Thoulet. (*Science et Civilisation: Collection d'exposés synthétiques du savoir humain.*) Pp. ix+287. (Paris: Gauthier-Villars et Cie, 1922.) 9 francs.

THIS book is one of a series which offers a general account of modern scientific research in its relations to civilisation: it is written in a pleasant, continuous manner and, on the whole, is a very good exposition of the main results of physical oceanography. It follows the line of treatment which appears now to have become classical since the publication of Krümmell's big book in 1907–11: an account of the bottom of the ocean and its deposits; the physics and chemistry of sea water; waves and tides; and the formation of ice. The ocean in its relation to life and the development of the foreshore and coast-line are scarcely touched. The theory of the tides is dealt with very slightly, and the statement is made that all tidal problems have been elucidated by Airy's "théorie des ondulations": quite lately, of course, the dynamical theory of the tides has been almost transformed. There is no account of the methods of prediction.

In such a work as this figures and charts are indispensable, yet the book under review only contains eight text-figures and these are rather difficult diagrams. It can be read with advantage and by the non-professional reader only with constant reference to a good atlas of physical geography, and there is no such work in existence which includes all the recent investigations of marine currents and drifts. J. J.

The Misuse of Mind: A Study of Bergson's Attack on Intellectualism. By Karin Stephen. (International Library of Psychology, Philosophy, and Scientific Method.) Pp. 107. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1922.) 6*s.* 6*d.* net.

THIS important study of Bergson's philosophy is not an attempt to epitomise or expound the principle, the method, or the particular content. It concentrates on an attempt to understand what is generally rejected as unintelligible—the attack on intellectualism. In Bergson's view the tradition of philosophy is all wrong and must be broken with; philosophical knowledge can be obtained only by "a reversal of the usual work of the intellect." The author gives us in three chapters first a criticism of "explanation," then a criticism of "fact," both with reference to Bergson's theory of change, and in a final chapter shows how light is thrown on the problem by his theory of the relation of matter to memory.

Les Sciences et le Pluralisme. Par J.-H. Rosny, aîné. (Nouvelle Collection Scientifique.) Pp. iv+219. (Paris: Félix Alcan, 1922.) 8 francs net.

M. ROSNY'S thesis is that "pour retrouver l'uniforme nous sommes contraints de nous rabattre sur des substances ou des énergies hypothétiques. En fin de compte, l'homogène que nous trouvons est subi ou créé par le moi, mais non strictement *donné par les choses*." The volume contains a lucid discussion of the most recent theories in mathematics and physics.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Mersenne's Numbers.

IN my presidential address to Section A of the British Association, reprinted in NATURE (September 16), I stated that 137 was the least value of n for which the prime or composite character of $2^n - 1$ was still undecided. Mr. W. W. Rouse Ball has pointed out to me that this is incorrect, as $2^{137} - 1$ has been shown to be composite by M. A. Gérardin (*Comptes rendus du Congrès des Sociétés Savantes*, 1920, pp. 53-55). The result is quoted in *The American Mathematical Monthly*, vol. 28, 1921, p. 380. The number 139 should therefore be substituted for 137 wherever it occurs in my address.

The authorities on which I relied were Prof. L. E. Dickson's "History of the Theory of Numbers" (vol. 1, Washington, 1919) and the seventh edition of Mr. Rouse Ball's "Mathematical Recreations" (1917, now superseded by the tenth). My quotation from Mr. Rouse Ball was taken, as I stated, from a pamphlet written thirty years ago, and is, of course, not to be interpreted as an expression of his present view.

G. H. HARDY.

New College, Oxford, October 4.

Animal Mechanism.

THE notion that the legs of animals behave as pendulums is ascribed to the brothers Weber. I can find no indication that the notion was more than a general one, and, in the general sense, when pointed out, it is obvious to a student of dynamics, for legs have inertia and weight and dynamics is reasonably near to the truth.

A better view may arise from the supposition that animals may be regarded as dynamical systems with many natural modes and frequencies, and that animals adapt their methods of locomotion and other actions to suit these fundamental characteristics. As examples, we have the lounging gait of very tall men and the apparently energetic step of short men. The tripping, half running step of women and children is also in point. Apart from mere legs the moment of inertia about the feet must be important, as may be seen in the stately carriage of quite short women in the East when carrying water vessels on the head. Sir George Greenhill has given several examples of this in his notes on dynamics, among them being interesting examples of the carrying of soldiers' kit.

A further point of interest arises in regarding legs a little closely, for they are not simple but multiple pendulums with more than one natural mode. When a horse or man is walking the leg appears to vibrate in the slowest mode of the pendulum and the joints are or appear to be on one side of the vertical. In the running gait, however, the thigh points forward while the lower parts point backwards. Probably the "reason" why a horse's forelegs are more flexible than the hind legs is to make him nimble in balance and steering; a horse could not stumble with his stiff hind legs.

The dynamics of locomotion is of interest to the student of engine balancing, for in the natural gaits of man and horse there is a utilisation of balancing principles. In man the right leg moves forward while the right arm moves backward, in the horse the right legs are always moving in opposition and similarly the left legs, of course. This holds for the walk, the trot, and the gallop, all natural modes. In the amble, an artificial stride due to the trainer, the legs on either side are in phase and an ungainly motion results, though it is comfortable for the rider. This amble stride is natural to the giraffe, but the latter has a long neck to give it poise. The balancing view of animal locomotion may be realised at once by any one who will try to run with stiff arms or will try to walk with his arms tucked up in the running posture. The runner is compelled by dynamics to move his legs in a quicker mode than when walking. His arms are so jointed that he cannot alter their type of vibration, and he is therefore compelled to reduce their inertia in order that they may oscillate in time with his legs. The balance from the engineer's point of view is imperfect, and thus stresses are imposed in the trunk. Hence sprinters are well-bodied men and horses need girth for speed. As a final example of these facts, let any one try to run to the station with a heavy suit-case in his hand. Porters usually carry such things on their shoulders and stride rather slowly.

There is a further point of interest in connexion with the viscera. If dynamics is true, the various internal organs have inertia and their attachments have elasticity; thus they must possess natural frequencies. This being so, they must be subject more or less to the phenomena of resonance. Is sea-sickness, subjective agencies apart, to be explained in this way? Some people before embarking have a copious meal, others pin their faith and hope to a single bottle of stout, while yet others proceed fasting. Is this a phase of dynamical tuning? In 1914 I read a short paper on the dynamics of the human foot at the British Medical Association's summer meeting. The outcome of the discussion was that tonicity was more potent than mechanics, or, in other words, living tissue may vary in its properties on account of tone or debility to a degree which will exceed the influence of configuration. The contention would be that while astringents or food may alter the effects of a sea voyage, the action is due to dynamical effects; the inertia of the stomach or the stiffness of its suspension is varied—opiates and such like are here excluded.

A medical writer of some eminence recently advocated walking because "Nature has ordained that the finest exercise of all is that which she bestows." While this is reminiscent of Heine's "Harzreise," the greenness of grass and the length of a donkey's ears, there is in it matter for reflection. Motor car designers, led by Dr. Lanchester, have found that the most comfortable predominant natural frequency of a motor car is between 80 and 100 per minute; it is a curious coincidence that this is also the frequency of the ordinary walking step. Has the human system, enforced by dynamics to walk in a certain rhythm, acquired an internal system and a nervous organisation to meet this rhythm? It is worthy of note that in certain cars several dogs and children have been actually and violently sick and in other cars sprung to vibrate with a different natural period they are immune. Shall we, disagreeing with Shylock, say, "It is not their humour, but their natural frequency"?

H. S. ROWELL,
Director of Research,
Research Association of British Motor
and Allied Manufacturers.

15 Bolton Road, W.4, September 20.

Vegetable Rennet.

I HAVE been endeavouring to make a list of plants—leaves, flowers, seeds, etc.—used in various countries for coagulating milk in place of rennet, obtained from the stomachs of young animals; and I shall be glad to learn of any additions that might be made to the following list:—*Galium verum, Withania coagulans, Ficus Carica, Cynara cardunculus, Cynara scolymus, Carduus nutans, Cnicus benedictus, Drosera peltata, Datura Stramonium, Pisum sativum, Lupinus hirsutus, Ricinus hirsutus, Pinguicula vulgaris, Leucas cephalotes, Crotalaria Burhia, Rhazya stricta* and *Streblus asper*.

With regard to some of the plants named above, I would note that the references are not very clear as to their use for milk coagulation. Any information as to plants used in former days or at the present time would be welcome and useful. A Hindu, also an orthodox Jew, cannot touch, I understand, a milk product that has been coagulated by rennet obtained from a calf's stomach, and must therefore use a vegetable coagulant; and I believe that there are other races in other parts of the world which use vegetable coagulants. So far as I am aware, an approximately complete list of plants used in various parts of the world for coagulating milk does not exist, and where a reference is found, details given are scanty as to part of plant used, its preparation, and method of use. R. HEDGER WALLACE.

4 East Grove, Cardiff, September 20.

A Question of Nomenclature.

IN his notice of Mr. S. Q. Hayes's "Switching Equipment for Power Control" in NATURE of September 16, p. 374, your reviewer, commenting on current Americanese, says: "Electrical engineers talked about 'omnibus bars' thirty years ago, it then became 'bus bars,' and now apparently it has become 'busses.'" Webster, who may be considered as an authority on the language of that great nation, defines a buss as "a kiss; a rude or playful kiss; a smack," and quotes Herrick to the effect that:

Kissing and bussing differ both in this,
We buss our wantons, but our wives we kiss.

So that although in both "bus bars" and "busses" there is intimate contact and at times electricity passes, it can scarcely be said that the two terms are synonymous. Nor can it be said that the introduction of such terms into electrical engineering is to be commended. F. H. MASTERS.

Capillarity.

IN a letter on capillarity in NATURE for September 16, p. 377, Mr. Wilson Taylor shows how difficult it is to account on physical grounds for the phenomena exhibited by liquid films.

It may not be out of place in the circumstances to refer to Irving Langmuir's views on this subject, given by him in a paper on "The Constitution and Fundamental Properties of Solids and Liquids. II. Liquids" (Am. Chem. Soc., vol. xxxix., September 1917, p. 1852). Langmuir cites a few of the cases in which the forces between the molecules have been considered to be radial forces which vary solely as a function of the distance between molecules. In all these cases the investigator has considered the phenomena to be physical in nature. He then goes on to remark: "The chemist, on the other hand, in studying the properties of matter, usually employs totally different methods. He is often most interested in the qualitative aspects of the problem, and the quantitative relationships are usually limited to those deducible from the law of multiple combining proportions, the law of mass action, or the principles of thermodynamics. When the chemist does consider the forces acting between atoms and molecules, he does not look upon these as forces of attraction between the centres of the molecules, but he thinks rather of the specific nature of the atoms forming the molecules and the manner in which these atoms are already combined with each other. He thinks of molecules as complex structures, the different portions of which can act entirely differently towards any given reagent. Furthermore, he considers that the forces involved in chemical changes have a range of action which is usually much less than the diameter of a molecule, and perhaps even less than that of an atom."

What has been termed the Classical Theory of surface forces has proved useful in its day; but it unfortunately ignores *chemical affinity*.

R. M. DEELEY.

Tintagil, Kew Gardens Road, Kew, Surrey, September 15.

Lead and Animal Life.

DR. GARRETT'S communication in NATURE of September 16, p. 380, on the effect of a lead salt on Lepidopterous larvæ, is particularly interesting to one who has been working on an allied subject. Recent investigations of my own on the fauna of lead-polluted streams in North Cardiganshire, as reported at the Hull meeting of the British Association, point to the presence of dissolved lead-salts in these rivers as distinctly inimical to the aquatic population, in particular to the larvæ of certain insect-groups, such as Trichoptera, which are normally non-existent in these streams, though well represented in their neighbours.

The case of fattening of Weardale sheep on lead-polluted pastures may perhaps provide a parallel; while it is quite possible that small doses of lead may have a tonic effect, cases of lead-poisoning proper among farm live-stock in general are common in certain districts (see a paper on "Plumbism in N. Cards." by E. Morgan, *Journal of U.C.W. Agricultural Dept.*, 1915), and usually the poisoning is of the type known as "chronic," the effect being slow and cumulative, as is also established in the case of lead-poisoning as an industrial disease. It would be interesting to know whether Dr. Garrett's experiments have extended over more than one generation of Lepidoptera, and whether the reproductive faculties were in any way affected. K. CARPENTER.

Department of Zoology, University College of Wales, Aberystwyth.

Polar and Non-Polar Valency in Organic Compounds.

THERE is an increasing tendency on the part of organic chemists to apply the Berzelius dualistic theory, in a modified form, to organic compounds. In many theories of valency, individual groups are considered to be more or less electropositive or electronegative, and it is possible to arrange these groups, approximately, in a table of descending electropositive character. A difficulty which arises in examining this conception is to visualise the transference of anything less than one electron between the group and the remainder of the molecule. There appear to be at least two kinds of forces operating between atoms in a molecule, which can

be designated as polar and non-polar. The polar character of the valency in the majority of salts is definite; there is experimental evidence for the transference of electrons in these substances. The non-polar forces are particularly in evidence in the linkings of organic compounds, and it is extremely unlikely that transference takes place to an appreciable extent here. Without entering into a discussion of the nature of the non-polar forces, which may be electromagnetic, there are two explanations which may be given of the undoubted positive and negative relationships of groups in organic compounds. In the first place, there may be a partial transference of an electron between the group and the residue of the molecule, or alternately there may be a varying concentration of polar molecules in the typically non-polar substance.

I venture to put forward a plea for the consideration of this second possibility. An equilibrium may be imagined to exist between the polar and non-polar substances which will be affected by the temperature, solvent in which it is dissolved, etc. Thus, in an organic substance AX the equation,

$$\overset{-\,+}{AX} \rightleftharpoons AX \rightleftharpoons \overset{+\,-}{AX}$$

may represent this kind of equilibrium, and the more electronegative the group X the more will this reaction proceed to the right. In those substances where the stability of the non-polar arrangement is very great, the occurrence of both forms, $\overset{-\,+}{AX}$ and $\overset{+\,-}{AX}$, will be possible, and in the presence of a suitable solvent these may give rise to the respective ions. This view is in agreement with the occurrence of a group in some compounds with an electropositive, and in others with an electronegative tendency. The ease of replacement of the group X by another group will be determined by the concentrations of the polar body, the polar state being the active form of the substance. These concentrations may be so small as to escape the ordinary methods of measurement, and yet be sufficiently great to explain the velocity of the chemical action.

W. E. GARNER.

University College, Gower Street, W.C.1,
October 4.

The X-ray Structure of Potassium Cyanide.

WRITING in a contemporary (J.A.C.S., Feb. 1922), Richard M. Bozorth gives details of X-ray investigations into the crystalline structure of KCN, and corroborates the view expressed in a letter to this journal (NATURE, Aug. 11, 1921, vol. 107, p. 745) that the underlying structure is the face-centred cube. He gives 6·55 Å as the length of its edge, which agrees very well with the 6·54 Å furnished by my measurements. He goes further in that he assigns definite positions to the carbon and nitrogen atoms and questions the opinion, expressed by Langmuir, that these constituent atoms of the CN radicle have a common outer electron shell.

Bozorth's conclusions are, to a certain extent, based on the assumption that the relative intensities of the spectra would fall off in a normal manner if the structure were quite like that of NaCl, that is, if the carbon and nitrogen atoms formed a single cluster of electrons which occupied the same position in the KCN structure as the chlorine atom does in NaCl. He publishes no numbers representing the observed intensities, but gives 100 : 10 : 3 as the relative values of the [100], [200], and [300] reflections that would be required to satisfy the requirements of his particular structure. My own measurements gave 16-17 as the relative value to be assigned to the [200] reflection, and the corresponding figure for NaCl is 20. Now the fact that KCN has a lower fusing-point than NaCl suggests that even at ordinary temperatures the heat vibrations are of unusual amplitude, and this in itself affords a ready explanation of the fact that the intensities of the spectra die away more rapidly than is normally the case. The probable electron distribution in a composite CN radicle is another important factor which would cause the normal sequence to fall off rapidly.

Bozorth gives 1·15 Å as the distance between the centres of the carbon and nitrogen atoms, and 3·0 Å as the distance between either of these and the potassium atom. He treats the carbon and nitrogen atoms as though they were of the same size, but he does not state whether or not the inter-nuclei distance is to be taken also as the effective diameter. In one case his figures would give 4·85 Å as the diameter of the potassium atom compared with 4·15 Å, which represents, probably to within 0·03 Å, its value in the other ionised salts in which it occurs (W. L. Bragg, *Phil. Mag.*, Aug. 1920). If, on the other hand, 4·15 Å be accepted as its diameter in KCN—and measurements on NaCN justify this procedure—then Bozorth's figures would give 1·85 Å as the effective diameters of both carbon and nitrogen; W. L. Bragg's values are 1·54 Å and 1·30 Å respectively.

Fortunately, there is outside evidence which bears directly on this question. From viscosity measurements A. O. Rankine has found (Proc. Roy. Soc., July 1921) that the C_2N_2 molecule behaves in collision like two overlapping hard spheres, each having the size of a bromine atom. The diameter of the bromine atom is 2·38 Å, and that of a Langmuir CN radicle, as provided by X-ray measurements, is 2·39 Å.

P. A. COOPER.

Research Dept., Royal Arsenal, Woolwich,
September 20.

Sex Change in Mollusca.

WITH reference to Dr. R. Spärck's statement (NATURE, October 7, p. 480) that the male stage in the oyster is due to the coldness of the temperature, it should be pointed out that in various hermaphrodite mollusca, such as Helix and Arion, the reason for the passage of the indifferent epithelial cell, either to oogonium or spermatogonium, is at present unknown. Older authors considered that those cells near yolk, or near a superior nutrimental radius became eggs, and that those less exposed to steady streams of nourishment became spermatocytes.

More recent work has shown that the matter is very deep-seated, and such a conclusion as the above cannot be taken as representing the real state of affairs. I have found that oocytes appear in regions of the ovotestis which are scantily provided with yolk, and that sperm cells appear in regions rich in nutriment.

Whether temperature has anything to do with this has not yet been ascertained, but experiments are now in progress, which should settle the question.

In the case of Saccocirrus it has been shown that spermatocytes caught up and enclosed in yolk cells have their metabolism so altered that they assume the appearance of oocytes, together with nucleolar extrusions characteristic of the typical oocyte.

But in Helix two epithelial cells side by side often metamorphose, one into an oogonium, another into a spermatogonium, and one seems obliged to believe that factors other than temperature or abundance of nutriment are concerned. J. BRONTË GATENBY.

Trinity College, Dublin University,
October 7.

The Galactic System.[1]

By Dr. HARLOW SHAPLEY.

I.

THROUGHOUT the known sidereal universe there is, among material bodies, an obvious associative tendency, which we see well illustrated in meteor showers, in satellite and planetary systems, in binary stars, and in larger stellar groups such as the Pleiades. These various products of gravitational ordering are clearly but parts of still greater systems, and one of the most fascinating of astronomical studies is to attempt to seek out the structure of an all-inclusive sidereal organisation.

It is proposed in this communication to discuss the structure and extent of the sidereal system as indicated by recent studies of stellar clusters and variable stars. My own observational investigations of these objects, and the deductions based upon them, have been mainly published in Contributions and Communications of the Mount Wilson Observatory [1] from 1914 to 1918. The present discussion is made in the light of criticisms and numerous tests to which the conclusions have been subjected during the past four or five years.

It appears that we have three principal types of celestial objects to consider—the diffuse nebulæ, the stars, and the nebulæ of the spiral family. The first two are generally thought to be related as parent and offspring. The stars, having formed, as we think, out of nebulous pre-stellar states, are, apparently, largely organised into groups, a common, possibly prevailing form being the globular cluster. It is from combinations of these clusters that I believe our galactic system has developed.[2] From the work on clusters there can be little doubt of the enormous mass and dimensions of the galactic system as compared with clusters and nebulæ. Its flat form and heterogeneity, its content of numerous fragmentary systems (open clusters, wide binaries, spectrally-similar groups) of apparently different ages and separate origins, and its control over the motions of the clusters and near-by spirals, have led me for some years to advocate the hypothesis that the Galaxy is a growing composite of disintegrating minor systems. The Galaxy appears to include all the common sidereal types, with the probable exception of most nebulæ of the spiral family. But the latter are apparently not stellar in composition, nor galactic in size. I think present evidence favours but does not establish the hypothesis that typical spiral nebulæ represent a sidereal evolution not directly connected with that of stars.

The foregoing paragraph may serve as a brief outline. Some of the details may now be considered, but, before proceeding with the discussion, I should like to point out that the proposed interpretations involve the following somewhat fundamental assumptions, if we choose to call them assumptions: (1) that gravitation directs the organisation and motions of celestial bodies; (2) that the physical laws we know are equally valid in all parts of the space with which we are familiar; (3) that the Russell-Eddington theory of stellar evolution is correct in its general features.

Certainly these three are not serious restrictions. On the first I need make no comment here. The second is the basis of our belief in the general uniformity of conditions throughout the stellar system. It insists that our stellar neighbourhood is not operated by local laws. It is a highly reasonable but necessary assumption before we can safely compare the luminosities and other properties of stars near the sun with those of stars in distant parts of the galactic system. The third assumption, the Russell-Eddington theory, is not necessary for my conclusions concerning the dimensions of the galactic system, but is essential in putting together the general scheme, and also in trying to interpret some anomalies of the spiral nebulæ. We might call the evolutionary scheme the Lane-Lockyer - Ritter - Sampson - Emden - Schwarzschild - Hertzsprung - Russell - Eddington - Jeans - Eggert theory, but Russell and Eddington have been the most important contributors to the theory in its present form.

CONCERNING STAR CLUSTERS.

Clusters of stars can be placed in two fairly distinct categories, the globular cluster, of which nearly ninety are now known, and the open or loose cluster, of which there are several hundred.

Most globular clusters (but not quite all) appear to be remarkably alike in general structure. Compared with naked-eye objects they are extremely remote; hence their stars, though apparently very faint, are actually of high intrinsic luminosity. Few stars in globular clusters are brighter than the eleventh apparent magnitude. Each globular cluster contains some tens of thousands of these intrinsically bright stars, and possibly a far greater number of dwarfs, which at present are beyond the reach of our telescopes. Of high importance is the fact that the cluster stars appear to be remarkably similar to the stars in the solar neighbourhood in spectral type, colour, variability, and other properties, notwithstanding the much higher stellar density near the centres of globular clusters.

Open clusters are of great variety. They range in brightness from naked-eye systems, such as the Hyades, to small, dim groupings that may be nothing more than chance aggregations of faint Milky Way stars. Open clusters vary also in richness, in apparent and real dimensions, in stellar content. One property they have in common: they are all near the plane of the Milky Way. The distance of the average open cluster is smaller than that of globular clusters, but the determination of distances for the former is generally subject to much uncertainty. This fact is due to variety of form and content, and to the absence from open clusters of peculiar types of highly luminous stars, which for globular clusters serve to determine positions in space.

The estimation of the distances of globular clusters, which has been the most important part of the work on the scale of the sidereal universe, must be based on the newer methods of measuring space. The various trigonometrical methods, when applied to globular clusters, so far give negative results, indicating only that the distances are very great. The various photo-

[1] Adapted from an Address given before the British Astronomical Association on May 31.

metric methods that had to be developed for this problem involve a considerable amount of photometric, spectroscopic, and statistical detail when put on a quantitative basis, and cannot be fully described in this article.

The qualitative application of the photometric methods, however, is simple. For example, we need only assume that the brightest stars in a globular cluster have the same actual luminosity as the brightest stars in the solar neighbourhood, and we can readily compute the distance necessary to give them the apparent brightness that is measured.

If we admit the similarity of globular clusters, it is obvious that either the apparent magnitude or the apparent diameter can give us the distances of them all when once we have determined the distances of those nearer the earth. In practice the distances of the nearest clusters have been determined from studies of their variable stars, of their blue stars (spectral type B), and of their red giant stars; and checked by spectroscopically-determined absolute magnitudes and by means of the relative diameters. All the methods agree in giving distances of the same order of magnitude. We thus find that the globular clusters range in distance from seven thousand parsecs to values nearly ten times as great. Their diameters are of the order of a hundred parsecs. Their brightest stars are a thousand times as bright as the sun.

The Structure of the Galaxy.

The result of most interest that comes out of this photometric investigation is the enormous dimensions of the super-system of globular clusters and of the Galaxy. Once the positions in space are determined, it becomes clear, as had already been suspected from an inspection of the apparent distribution of clusters in the sky, that globular clusters are a part of the Milky Way system. They are associated physically with the system of stars, nebulæ, and open clusters which is more or less symmetrically arranged with respect to the equatorial plane of the Galaxy. In measuring the distances of the remotest globular clusters, therefore, we are but measuring the depth of our own galactic system. That the Milky Way itself extends to distances as great as those indicated by the clusters is shown by the presence within it of highly luminous types of stars with apparent magnitude 15 and fainter.

It has been known for many years that globular clusters are not uniformly distributed in galactic longitude. They are most numerous along the edges of the southern Milky Way. That one-sided distribution is now recognised as an indication of the sun's very eccentric position in the galactic system. In this same southern part of the sky we find the densest galactic star-clouds and the greatest frequency of faint novæ and of other types of distant objects, which is but further evidence of the greater depth of the galactic system in the direction of Sagittarius. Also in that general direction are some obstructing dark nebulæ, which may be wholly responsible for a peculiar phenomenon in the distribution of distant globular clusters, that is, in their seeming absence from regions very close to the galactic plane. If the obstructing material were removed, we might see, near the galactic plane, clouds of faint Milky Way stars still more dazzling than those observed, and globular clusters still more distant than those now known, and hence find that the greatest diameter of the galactic system is even larger than the value now assigned—approximately 100,000 parsecs.

The observable dynamical relations within and without the Milky Way are suggestive of its origin. No open clusters have yet been found outside the Milky Way region, but hundreds are known within. North and south of the galactic plane the globular clusters are equal in number, and their distances from the plane are much smaller than the greatest diameter of the system. Their velocities, so far as now known, are high. Many are approaching the galactic plane with speeds that soon must bring them to it. Their present positions and motions make orbital motion around the Milky Way improbable. From the present evidence as to mass, velocity, and distribution, there can be little doubt but that the known globular clusters pass to and fro through the star fields of the galactic system, notwithstanding their observed avoidance, apparent or temporary, at the present time. Every passage must reduce the velocity and alter the form. The hypothesis that these globular clusters are being diverted by degrees into galactic regions, and gradually robbed of their stars, is upheld by observation and is not opposed by present dynamical theory. Although we see few intermediates between the globular and the more typical open clusters, many of the characteristics of the open groups strongly support the suggestion that they are the remnants of globular clusters or of other systems that have been assimilated by the incomparably more massive galactic assemblage. Nearly a dozen "moving" clusters, comprising thousands of members, are recognised among the stars within seven hundred light-years of the sun.

Two important theoretical researches by Jeans are of much significance in this view of galactic structure: (i.) the form resulting from the interpenetration of two clusters,[3] and (ii.) the necessity, in accounting for the present orbits of long-period binaries, of assuming their former existence in a much more compact stellar field than now exists in the solar neighbourhood.[4] The high stellar frequency near the centre of a globular cluster would certainly supply conditions favourable for modifying orbits, and it also might aid in explaining the origin of long-period binaries which is not otherwise accounted for satisfactorily.

The determination, with the aid of clusters, of dimensions for the galactic system much larger than had been clearly indicated by studies of the nearer galactic stars, led to a further examination of the stellar distribution in the solar neighbourhood. The hypothesis that the galactic system, as we now know it, has developed from the combination of minor groups, suggests that the brighter stars near the sun may to a large extent be members of a local system that is imbedded in and moving through the general star fields of the Milky Way. This condition actually appears to be the case, and hence the results on galactic dimensions, from clusters and from the nearer stars, do not contradict. Stars of spectral type B down to the sixth apparent magnitude seem to be almost exclusively members of a local cluster or cloud. Brighter stars of Class A are also affiliated with the same system.[5] Probably all

the other types are to some extent involved,[6] but for them the disentanglement of local system and galactic field is more difficult.

Quite analogous to the phenomenon of the Milky Way, the projection on the sky of the faint stars along the central plane of this local cloud gives rise to a sort of secondary Galaxy,[7] the brighter stars of which coincide roughly with the Herschel-Gould belt. The distribution of the B stars indicates that the dimensions of the local system are large compared with those of a globular cluster; the local system is also more oblate. I believe it can be better compared in dimensions, and possibly in form, with the Magellanic Clouds or with the distinctly delimited small star clouds of the Milky Way. The various phenomena of star streaming are undoubtedly connected with the motions of and within the local system. Probably a number of our brighter "moving" clusters should be considered sub-systems in the local cloud, rather than independent systems which for the time being are near at hand.

(*To be continued.*)

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Transport of Organic Substances in Plants.[1]

By Prof. H. H. DIXON, Sc.D., F.R.S.

AMONG physiologists the usually accepted view is that organic substances are distributed throughout the plant by means of the bast. The wood also acts as a channel of distribution for these substances to opening buds and developing leaves, especially in spring when root-pressure is active. The sap of bleeding contains appreciable quantities of these substances, and their distribution to the developing buds in spring by means of the wood was recognised by Hartig and Sachs.

This upward transport of carbohydrates in the tracheæ seems to be accompanied with smaller amounts of proteins. Thus Schroeder showed that the quantity of proteins in the bleeding sap rises and falls with the quantity of sugar.

This view that the rising current in the tracheæ carries organic substances in it and distributes them to the growing regions has lately been impugned. It was pointed out that in many cases, ringing close below the terminal bud prevents the development of that bud because the wood is unable to transmit sufficient supplies of organic substance. As Strasburger has already shown, this interpretation rests upon the fallacy of supposing that the removal of the bark as far as the cambium leaves the wood uninjured. As a matter of fact, microscopic examination of the wood, from which the outer tissues have been stripped, shows that its tracheæ soon become blocked with air-bubbles and with substances probably exuded into them and their walls during morbid changes in the cells of the cambium, in the cells of the medullary rays, and in those of the wood-parenchyma. The blocking is accompanied with discoloration, and is most apparent in the outer layers of the wood. It is only reasonable to suppose that the efficiency of the tracheæ as channels of transmission is seriously impaired even before there is visible evidence of plugging.

It is evident that this clogging may act differentially on the water and the substances carried in it. In the first place, the whole cross-section of the wood is available for the transport of water, while probably the outer layers are mainly utilised by the organic substances. Further, colloidal deposits in the walls, and especially in the pit-membranes, would obstruct the passage of organic substances much more than they would the water which carries them. These considerations readily explain how it is that, while the water-supply to the buds of ringed branches is adequate, the supply of organic substance may be deficient.

Apart, then, from the very slow movement of organic substances from cell to cell, there is very cogent evidence that their upward motion is effected in the tracheæ of the wood. There is no reason to believe that during this transport the walls or pit-membranes of these tracheæ oppose the passage of the dissolved carbohydrates or of the simpler proteins any more than the water which conveys them. Hence the velocity of transport of these organic substances is that of the transpiration current, and the amount conveyed in a given time depends on the velocity and concentration of the stream.

The transport of organic substances in an upward direction in plants is secondary, for, as is well known, carbohydrates certainly, and proteins most probably, are manufactured only in the upper green parts of plants—principally in the leaves, and must be transported in the first instance back from these to the stems to be distributed to the growing regions and to the storage organs.

This view that the channel for the backward and downward movement of organic substances is afforded by the bast received great support from Czapek's work published in 1897. By section of the conducting tracts in one half of the petiole he showed that depletion of the corresponding half of the blade was delayed. He also showed that only where vertical bridges connected the upper and lower portions of bark in ringed stems were the effects of ringing nullified. Oblique and zigzag bridges are ineffective. Thus transverse conveyance in the stem is negligible. The parallel and longitudinal arrangement of the elongated elements in the bast seemed to him to provide adequately for the observed longitudinal passage. Their narrowness and large colloid content did not present themselves as difficulties. Czapek also recorded the observation that the blades of leaves, the petioles of which had been killed by jacketing them with steam, did not become emptied of starch. Similarly, when the petioles were killed with chloroform-vapour, depletion was arrested. Again, anæsthetisation of the petiole, by surrounding

[1] From the presidential address delivered to Section K (Botany) of the British Association at Hull on Sept. 7.

it with a watery solution of chloroform, greatly delayed the disappearance of starch.

Czapek formed no definite theory as to how organic substances were moved in the bast. He was sure that the transport depends on living protoplasm. He did not consider that the streaming of protoplasm contributed materially to the motion, seeing that streaming does not occur in mature sieve-tubes. He regarded the sieve-tubes as the most important elements in the transmission of these substances, because the deposition of callus in the sieve-plates synchronises with the stoppage of transport. The transport, according to him, is not simply due to diffusion. He supposed the protoplasm to take up the organic substances and pass them on. If diffusion does not account for the passage from one particle of protoplasm to the next, it would seem that we must suppose the organic substance to be projected from one to the other.

These observations and their interpretation by Czapek have strengthened the opinion that the bast is the channel for the downward transport of organic substances. It is remarkable how little weight has been attached to the damaging criticism of Czapek's views by Deleano, especially as those views are so unsatisfactory from a physical point of view.

The latter author showed that it is inadmissible to compare externally similar leaves, which often behave, so far as depletion is concerned, very dissimilarly. He also pointed out that without any export a leaf may be depleted of all its starch within thirty-five hours, and partially anticipated an extremely interesting recent observation of Molisch—namely, that transpiring leaves lose their carbohydrates much more rapidly than those the transpiration from which is checked by being surrounded with a saturated atmosphere. Neglect of these facts led Czapek into error. Deleano also showed that organic substances continue to leave the blades even after the petioles have been killed by heat or by chloroform-vapour. The rate of depletion is reduced by the former agent to about one-third, and by the latter to one-half. If this observation is substantiated it would show that the intervention of living elements is not essential for the transport. He further found that the blades attached to petioles which were surrounded by chloroform-water lost their starch more quickly than those immersed in water.

The contradictory conclusions of Czapek and Deleano urgently call for a reinvestigation of the points at issue. If Czapek's work holds good, we shall have to regard the bast, and especially the sieve-tubes, as the channels for the transport of organic substances back from the leaf-blades where they are manufactured, and we must look for some hitherto undreamed-of method of transmission through these most unlikely-looking conduits. On the other hand, if Deleano's conclusions are borne out, we should admit that protoplasm is not necessary for the transport, and we would turn to a dead tissue as furnishing this channel.

So far as I am aware none of the earlier investigators made any estimate either of the actual quantities of organic material which are transported or of the velocities of flow in the channels which are necessary to effect this transport.

We may approach this problem from two opposite directions—(1) by dealing with the amount of organic substance accumulated in a given time in a storage organ, or (2) by using the amount exported from an assimilating organ. The cross-section of the supposed channels of transport and the volume of the solution containing the substances in each case will give us the other necessary data.

For the first method a potato-tuber will furnish an example. One weighing 210 g. was found attached to the base of a plant by a slender branch about 0·16 cm. in diameter. In this branch the bast had a total cross-section of 0·0042 cm.^{2}. This figure is a maximum; no allowance was made for the cross-section of the cell-walls, or for any non-functional elements in the bast. The cell-walls would occupy probably one-fifth of the cross-section of the bast. Now if the bast exclusively furnished the channel of downward transport, all the organic substance in the potato must have passed this cross-section during the time occupied in the growth of the potato. One hundred days would be a liberal allowance. According to analyses more than 24 per cent. by weight of the potato is combustible. Therefore we must assume that during this time more than 50 g. of carbohydrate has passed down a conduit having a cross-section of no more than 0·0042 cm.^{2}. The average concentration of the solution carrying this substance could scarcely have been as much as 10 per cent. (2·5-5 per cent. would be more probable; the concentration of sugar in bleeding sap is much below this figure, and seems never to reach 4 per cent.). Assuming, however, this concentration, the volume of liquid conveying 50 g. must have been 500 cm.^{3}, and this quantity must have passed in 100 days. Therefore the average velocity of flow through this conduit, having a cross-section of 0·0042 cm.^{2}, must have been $\frac{500}{0\cdot0042 \times 100 \times 24}$, *i.e.* nearly 50 cm. per hour.

By the second method we arrive at a different figure. Various investigators, from Sachs onwards, have measured the rate of photo-synthesis per square metre of leaf per hour. Under the most favourable conditions the amount may approach 2 g., and it has been estimated as low as 0·5 g. Taking Brown and Morris's determination for *Tropæolum majus*, namely, 1 g. per square metre per hour, and assuming one-third of the carbohydrate formed is used in respiration in the leaf, we find that a leaf of 46 cm.^{2} may form during ten hours' sunshine 0·46 g.; during the twenty-four hours one-third of this will be respired, leaving 0·31 g. to be transported from the leaf. The volume of the solution (again assuming a concentration of 10 per cent.) will be 3.10 cm.^{3}. The cross-section of the bast of the bundles in the petiole was 0·0009 cm.^{2}; therefore the velocity of flow, if the bast was used as the channel of transport, must have been $\frac{3\cdot10}{0\cdot0009 \times 24}$ or 140 cm. per hour.

Similar figures to these were derived using measurements obtained from a number of potato-tubers and from various leaves. The velocities indicated, even assuming a concentration of 10 per cent., lay in all cases between 20 cm. and 140 cm. per hour. These figures are in agreement with those arrived at by Luise Birch-Hirschfeld, as to the weight of organic material transported from leaves.

A flow of this rate through the bast seems quite

impossible. The narrow transverse section of its elements, the frequent occurrence of transverse walls, and the lining of protoplasm and large protein contents practically preclude the mass movement of liquid through this tissue. If we imagine the flow restricted to the sieve-tubes the velocity must be correspondingly increased, and the excessively fine sieve-pores, more or less completely occupied by colloidal proteins, must be reckoned with. Simple diffusion, as Czapek recognised, cannot account for the transport, and there is no reason to suppose that adsorption on the surfaces of the colloid contents of the sieve-tubes can increase the velocity of diffusion, as Manghan suggests.

As soon as one realises the volume of the solution which has to be transported, and the velocity of the flow that this necessitates, one naturally turns to consider if the open capillary tubes of the wood may not be utilised as channels of transport. Deleano's results, indicating that the depletion of leaves continues even after the living elements of their petioles have been killed, support this conjecture.

The emphasis which has been laid on the function of the wood as providing a channel for the upward movement of water usually obscures its function as a downward and backward channel also. Early experimenters, however, fully recognised that, under certain conditions, the current in the wood may be reversed. There is, of course, recent work also showing this reversed current.

By means of an eosin solution this reversal of the transpiration current may be very easily demonstrated. If the tip of a leaf of a growing potato-plant is cut under eosin solution, the coloured solution is very quickly drawn back into the tracheæ of the conducting tracts of the leaf; from there it passes into those of the petiole, and makes its way not only into the upper branches and leaves, but also passing down the supporting stem may completely inject the tracheæ of the tuber, and from thence pass up into the wood of the remaining haulms of the plant. Its passage is entirely in the tracheæ of the wood of the conducting tracts.

Another very striking experiment may be carried out with the imparipinnate leaf of *Sambucus nigra*. Its petiole is split longitudinally for a few centimetres and half removed. The remaining half is set in a solution of eosin. The solution is rapidly drawn up the wood-capillaries of the intact half-petiole, and soon appears in the veins of the pinnæ on the same side of the leaf, beginning with the lowest, and gradually working up into the upper ones. Finally it appears in the terminal pinna. All this while the veins of the pinnæ on the other side remain uncoloured. Now, however, the eosin begins to debouch into the base of the uppermost of these pinnæ and spreads through its veins; finally it makes its way down the offside of the rachis to the bases of the lower pinnæ, and from thence spreads into their veins. In this case we see very clearly how transpiration actuates an upward current on one side and a downward current on the other. It is interesting to note that if the terminal pinna and its stalk is removed the eosin does not appear in the pinnæ of the second side, or only after a considerable time, when the small anastomosing conducting tracts are utilised.

Luise Birch-Hirschfeld also described recently many experiments with herbaceous and woody plants, tracing the path of the reversed current by means of lithium nitrate and eosin.

In all these cases the tension of the sap determines the flow from a source wherever situated, and transpiration from the leaves, or parts of leaves, which are not supplied with liquid water from without, draws the water through the plant along the channels of least resistance. Hence it is that if the cut vein of a lateral pinna provides the point of entry, the solution may pass backwards in some of the conducting tracheæ, leaving others quite uncoloured, so that some of the veins only of the pinna are injected. The injected tracts bring the solution down the rachis and petiole into the stem, while a few or many, as the case may be, remain filled with colourless liquid, presumably the sap drawn upward to supply the transpiring surfaces of the leaf. Generally the coloured liquid descends an appreciable distance in the tracheæ of the stem before it begins to rise in the ascending current, mounting to other transpiring leaves. As a rule after some time—depending on the rate of transpiration and the amount of water supplied by the roots—the presence of the coloured liquid may be demonstrated in certain continuous series, or filaments of tracheæ in several bundles of the lower parts of the stems. Similarly, if tubers or rhizomes are present, examination of these parts, after a suitable interval, will show that many of their filaments of tracheæ are injected. Meanwhile the parts above the supplying leaf become coloured, and it will be seen that the distribution of coloured tracheæ is decided by the anatomical connexions of those filaments of tracheæ which convey the coloured liquid directly from the point of supply through the petiole to the stem. In tracing the path of the solution one is impressed with the fact that the path of least resistance is by no means always the shortest path in the wood. Transverse motion across several tracheæ seldom occurs, and the separate linear series of conducting tracheæ are practically isolated from each other laterally. Here we may recall Strasburger's experiments showing the very great resistance offered to the flow of water in a transverse direction in the wood of trees. This isolation of the separate filaments of tracheæ in the leaf and in the stem enables the tension developed by the transpiring cells of the leaves, while it raises a column of water in one series of tracheæ, to draw down a solution in a neighbouring filament of tracheæ terminating above in some local supply. If the anatomical connexion of the two series is located in a subterranean organ the tracheæ of the subterranean organ may become filled from that supply.

So far the evidence of reversed flow in the water-conducting tracts which we have been considering has been derived from plants under artificial conditions—plants the conducting tracts of which have been cut into and otherwise interfered with. Is there any evidence that reversal of the transpiration-current normally occurs in uninjured plants?

Some recent work on the transmission of stimuli seems to me to indicate that these reversals are continually occurring in normally growing plants.

The first piece of work to which I would direct attention is that of Ricca on Mimosa. It has long been known that the stimulus which causes the folding of the

pinnules and the bending of the petioles of Mimosa could traverse portions of the petioles or stems which had been raised to such a temperature as would kill the living elements in these organs. Notwithstanding that observation, Haberlandt's view, that the stimulus is transmitted as a wave of pressure through certain tubular elements of the bast, was generally accepted as the least objectionable of any of the theories which had been put forward to explain this transmission. Ricca saw that, among other difficulties, the slowness of transmission—never more than 15 mm. per second—was a grave objection to this view. Accordingly, working with a woody species of Mimosa—*Mimosa Spegazzinii*—he removed the whole bast and outer tissues of the stem for as many as twenty-three centimetres and was able to show that the stimulus was still transmitted. Similarly he found that the stimulus was transmitted through narrow strips of the wood from which even the pith had been removed. These experiments and others in which the transmitting organ had been killed for a considerable length caused Ricca to recognise that the stimulus is transmitted in the wood and not in the bast, as had been previously held. Thus he was led to assign the transmission to the transpiration-current. He was able to confirm this conjecture by showing that the transmission to the various leaves of a plant is largely controlled by the rate of the transpiration from the individual leaves. Thus, other things being equal, a rapidly transpiring leaf receives the stimulus sooner than a sluggishly transpiring one equidistant from the point of stimulation. He was able to show further that the stimulus may be transmitted through a glass tube filled with water, just as it is transmitted through a dead portion of the stem. Evidently a hormone set free into the transpiration-stream is the long-sought-for mechanism by which the stimulus is transmitted throughout Mimosa.

As the stimulus travels both in a basipetal and acropetal direction we may assume that movement of the transpiration-stream in a downward direction is of normal occurrence in plants.

Contemporaneous with, and subsequent to, Ricca's important work on Mimosa, experimental evidence has been accumulating to indicate that the transmission of other stimuli — phototropic, traumatotropic, thigmotropic, and geotropic — is effected by means of the passage of a dissolved substance. Boysen-Jensen appears to have been the first to announce that phototropic and geotropic stimuli may be transmitted across protoplasmic discontinuities. Paál emphasised this by showing that these stimuli are able to pass a disc of the tissue of *Arundo donax* impregnated with gelatine, which is interposed between the receptive and responding regions. These observations rendered the view that the stimulus is transmitted in the form of a hormone extremely probable; and later Stark showed that this hormone is thermostable, just as Ricca had done in the case of the hormone of Mimosa. Another very interesting point discovered by Stark—working with traumatic stimuli—is that the hormones are to a certain extent specific. Thus if the perceptive tip of a seedling is removed from one plant and affixed in position on another, the certainty of the response depends on the genetic affinity of the two plants.

In all these cases it seems certain that the perceptive tissues are the point of origin, when stimulated, of a dissolved substance, the hormone, which makes its way to the motile tissues and releases the response.

In the case of Mimosa just alluded to, and of the labellum of Masdevallia examined by Oliver, there is direct evidence that the transmission of the hormone is effected by the vascular bundles. In Mimosa the channels are more precisely localised as being the tracheæ of the wood. Furthermore, the rapidity of transmission renders it certain that simple diffusion through the tissues of the plant will not account for the process. Some recorded velocities of transmission are here enumerated for the sake of comparison:

Plant.	Nature of Stimulus.	Transmission Time in secs. per mm.
Mimosa	Heat	0·07
Drosera	Chemical	6·00
Seedling	Light	180-300
,,	Gravity	300
Tendril	Contact	17
Diffusion in tissue		2250-3600

There is thus every reason to believe that the transmission of stimuli generally through the tissues of the higher plants is effected by the conveyance of a hormone in the wood of the vascular bundles from the receptive to the motile regions, and whenever this transmission is in a downward direction evidence is afforded of the downward movement of water in the tracheæ. It is reasonable to suppose that this downward current is able to carry organic foodstuffs as well as hormones.

Thus the evidence for the existence of a backward flow of water in the tracheæ of wood, in addition to the more obvious upward stream, is convincing. With regard, however, to the mechanism by which the backward stream is supplied we have but scant information.

The volume-changes of leaves which Thoday has recorded are suggestive in this connexion. These changes he found of various magnitudes, occurring simultaneously in different or in the same leaves. They may cause a linear contraction amounting to 2·5 per cent. in ten minutes, and may produce a volume contraction of 7 per cent. in the same time. The water corresponding to this volume-change in the cells of the leaf if transmitted into the tracheæ would produce a considerable downward displacement, as may be seen from the following figures:

Name of Plant.	Volume of 1 per cent. Contraction in mm³.	Cross-section of Tracheæ in Petiole in mm².	Downward Movement in cm.
Aucuba japonica .	22·8	0·05	45·6
Solanum tuberosum	28·0	0·07	40·0
Syringa vulgaris .	42·15	0·013	16·5
Acer macrophyllum	42·2	0·22	19·2

If these changes in volume are caused by, or accompanied with, a development of permeability of the contracting cells, evidently a backward movement of organic substance having a velocity of about 120 cm. and more per hour would be produced.

It is possible that the tension which causes these contractions of the leaf-cells at the same time acts as a stimulus to increase the permeability of the plasmatic membranes of the cells; and so one might imagine that the development of a certain tension would automatically release organic substances from the cells and draw them through the tracheæ downwards. Direct experiment on this point presents difficulties, but it may be worth recording that when the internal osmotic pressure of the leaf-cells was overbalanced by an external gas-pressure, the water pressed from the cells and forced out of the tracheæ of the supporting stem was found to be practically pure, and if it contained carbohydrates they were in such small quantities that no reduction could be detected with Benedict's solution either before or after inversion. This experiment was repeated several times with branches of *Sambucus nigra* and *Tilia americana*. The cut branch, well supplied with water, was first exposed for several hours to conditions favourable to photosynthesis, and then either immediately or after a sojourn in darkness subjected to the gas-pressure. A pressure of thirteen atmospheres was found sufficient to drive water back from the leaves out of the stem.

Of course the conditions of this experiment are not those obtaining in the normal plant, where during transpiration the volume of a leaf, or part of a leaf, changes. In the transpiring plant we can also imagine the accumulation of a substance or an ion which would give rise to an alteration of the permeability of the plasmatic membranes of the leaves.

When, in order to imitate these conditions, the cells of the leaves in the foregoing experiment are rendered permeable by the introduction of a little toluene into the pressure-chamber, the application of a smaller pressure is sufficient to press the cell-contents into the water-channels and liquid emerges from the base of the stem which readily reduces Benedict's solution.

In the same way, if a pinna of *Sambucus nigra* is surrounded with toluene vapour, transpiration from the adjacent pinnæ draws back the cell-contents of the toluened pinna, and afterwards their track in the wood of the vascular bundles of the rachis may be traced by the browning of this tissue.

Another possibility presented itself, namely, that the direction of the current might act as a stimulus regulating the permeability of the cells in contact with the tracheæ. To test this, short lengths of stem set in their normal position were supplied, first through their lower and afterwards through their upper end, with distilled water. In neither case could carbohydrates be detected in the issuing stream.

The foregoing short consideration of some recent physiological work leads us, then, to the following conclusions:

The transport of the organic substances needed in the distal growing regions is effected through the tracheæ of the wood. The substances travel dissolved in the water filling these channels, which is moved by transpiration, expansion of the growing cells, or root pressure.

Physical considerations forbid us admitting that sufficiently rapid transport can be afforded by the bast either for the observed upward or downward distribution of organic substance.

The existence of downward as well as upward movement of water in the tracheæ of the wood may be demonstrated by suitable experimental means, and may be inferred by the transport of hormones in the wood.

The occurrence of local contractions in leaves suggests that local increases of permeability supply dissolved organic substances to the distal ends of certain of the filaments of tracheæ. The tension developed by the transpiration of other regions draws these along downward as well as upward channels in the wood.

In thus ruling out the participation of the bast in the longitudinal transport of organic substances in plants one naturally is forced to speculate on its probable function. Its distribution and conformation are such that, while it possesses a very small cross-section, it appears with the other living elements of the vascular bundles, medullary rays, wood-parenchyma, etc., to present a maximum surface to the tracheæ.

This large surface may find explanation in the necessity of interchange between the living cells and dead conduits. The colloidal contents of the former render this process slow, hence the necessity for the large surface of interchange to enable sufficient quantities of organic substances to be abstracted from and introduced into the tracheæ to meet the needs of the plant.

Before concluding I would like to add that the experimental work carried out on this matter would have been quite impossible for me were it not for the assistance and ingenuity of Mr. N. G. Ball. He also has contributed materially by his criticisms and suggestions.

Obituary.

COLONEL E. H. GROVE-HILLS, C.B.E., C.M.G., F.R.S.

COLONEL EDMOND HERBERT GROVE-HILLS, whose death occurred on October 2 at his residence at Campden Hill, W., was the son of Herbert A. Hills of High Head Castle, Cumberland. Born on August 1, 1864, he was educated at Winchester, whence in 1882 he passed into the Royal Military Academy, Woolwich. There his abilities were recognised as giving promise of a distinguished career, and he passed out as the senior cadet of his term, receiving a commission in the Royal Engineers in 1884.

Scientific subjects specially interested him, and in 1893 he was elected a fellow of the Royal Astronomical Society; in the following year a paper by him on the photographs of the spectrum of the eclipsed sun taken at the solar eclipse of April 1893 was communicated to the Royal Society. The study of solar physics strongly attracted him, and he also took part in the eclipse expeditions of 1896 to Japan, of 1898 to India, and in that of 1914 to Kieff, whence he was recalled on the outbreak of war to military service. In 1898 he took up the appointment of instructor in chemistry and photography at the School of Military

Engineering, but he had only held this for a year when he was transferred to the Topographical Section of the General Staff at the War Office. Here his scientific inclinations found full scope in the organisation of survey work in all parts of the world. During his tenure of the post he raised the standard of this work in a very notable degree, which was recognised by the C.M.G. being conferred on him in 1902. His work here brought him into contact with many problems in geodesy, in which he took a keen and lasting interest. At this time Sir David Gill was actively promoting the geodetic triangulation in South Africa, and to this Grove-Hills gave his whole-hearted support.

In 1905 he completed his period of service as head of the topographical department of the War Office, and then retired from the army. In the following year he contested Portsmouth in the Conservative interest unsuccessfully, and afterwards occupied himself mainly with scientific investigations. At the British Association in 1906 he raised the question whether the triangulation of this country was of the accuracy required by modern geodesy, and a few years later the Ordnance Survey undertook the re-observation of certain triangles in Scotland to determine this point. In the same year he and Sir Joseph Larmor discussed the movement of the pole in an important communication to the Royal Astronomical Society.

Col. Grove-Hills was president of Section E at the British Association meeting in 1908, where he discussed the surveys of the British Empire in an important address. He had before this been invited to report on the Canadian surveys and wrote a valuable and instructive report on them. In 1911 he was elected a Fellow of the Royal Society, and from 1913 to 1915 he was president of the Royal Astronomical Society. He was also latterly Secretary of the Royal Institution. Keenly interested in astronomy, he designed the suspended zenith instrument at Durham Observatory, of which institution he was Honorary Director up to the time of his death. While on his way to Kieff with the eclipse expedition of 1914 he was recalled to take his part in the Great War, and was appointed Assistant Chief Engineer of the Eastern Command, being gazetted Brigadier-General in 1918. His services in this responsible post were recognised by the award of the C.B.E. in 1919.

Endowed with very great natural ability, and a keen interest in all scientific questions, Grove-Hills combined with these great administrative ability and sound common sense. He was always ready to assist by his advice and active co-operation in any well-planned scheme of scientific work, and in his death astronomy and geodesy have suffered a severe loss.

H. G. L.

MAJOR-GENERAL J. WATERHOUSE.

MAJOR-GENERAL JAMES WATERHOUSE, who was eighty years of age, died on September 28. As a youth he joined the Royal Bengal Artillery, and after seven years was made Assistant Surveyor-General in charge of the photography section in the Surveyor-General's Office in Calcutta. He retired in 1897. His official duties necessitated the study of photography and photo-mechanical methods of reproduction, and this he did with a keen eye for any possible improvement, and a skilful hand which enabled him to test the practical value of any new introduction. He made an extended continental tour during his term of office that he might become acquainted with the methods employed in foreign photographic laboratories. A considerable number of improvements were introduced by Waterhouse in photolithography and allied processes, as well as in collotype, sometimes varying methods in use elsewhere to render them suitable for a tropical climate. His knowledge of these methods in all their minutiæ was very extensive, and in 1882–1885 he contributed to the *Photographic News* a series of fifty chapters on photolithography.

In 1873, when Vogel published his discovery that the sensitiveness of plates to green and red could be enhanced from a negligible to a practically useful amount by the use of certain dyes, Waterhouse was one of the very first to confirm the observation and to find other effective dyes. In 1890 he found that by the addition of thiourea to the developer the reversal of the image was so much facilitated that a very little, if any, increase of exposure was necessary. He took part in the observation of the total eclipses of 1871 and 1875, and in the transit of Venus in 1874.

On his retirement, Waterhouse studied the early history of the camera obscura, and of the action of light on silver salts, correcting some false and incomplete ideas that were current. He was president of the Royal Photographic Society from 1905 to 1907, honorary secretary of the Calcutta Zoological Gardens from 1894 to 1897, president of the Asiatic Society of Bengal from 1888 to 1890, and trustee and twice chairman of the Indian Museum at Calcutta. The value of his scientific work in connexion with photography was acknowledged by the award to him of the Progress Medal of the Royal Photographic Society, and the Voigtländer Medal of the Vienna Photographic Society.

WE regret to record the death of Prof. J. K. A. Wertheim Salomonson. He was born in 1864, passed his medical studies at the University of Leyden, and in 1899 became professor in neurology and radiology in the University of Amsterdam. His contributions to these two subjects were of considerable importance, for his range of knowledge of medicine and physics was supplemented by a perfection of skill in instrumental design. He was a frequent visitor to this country and only last year he demonstrated to the Ophthalmological Section of the Royal Society of Medicine a method for the photography of the structure of the eye. He was responsible for improvements in the electro-cardiograph and in many instruments designed for radiological purposes. A man of engaging personality, his loss will be felt over the wide circle which his scientific interests served. He was a Knight of the Order of the Lion of the Netherlands and an honorary member of the Röntgen Society. At the time of his death he held the office of rector magnificus at the University of Amsterdam.

Current Topics and Events.

AN announcement was made in the Press on October 10 by the British Broadcasting Company concerning the conditions which, in order to obtain Post Office approval, must be fulfilled by receiving apparatus intended for use in connexion with the broadcasting services. The conditions have been framed with the view of preventing the use, in such sets, of circuits which may "regenerate" oscillations and thus cause disturbances at receiving stations within their re-radiation range. Experience has indicated the need, in the case of receiving apparatus handled by an unskilful user, for some form of control in the type and design of the apparatus of the nature which is aimed at in the specification in question; the specification accordingly should serve a useful purpose. Exception has been taken in some quarters to the provisions contained in clause 10 of the conditions above referred to, on the ground that these particular conditions conflict with the promise made by the Postmaster-General in the House of Commons on July 27 last, to the effect that the owners of "home-made" receiving apparatus and the existing licencees of imported receiving sets would be allowed to use their apparatus for listening-in to broadcasted news, music, etc. This clause provides, *inter alia*, that "All sets sold under the broadcast licence shall bear the registered trade mark of the broadcasting company and the Post Office registered number." It has consequently been assumed that the issue of licences for receiving broadcasted matter will be confined to those who procure listening sets from the broadcasting company. It appears to have been overlooked, however, that the announcement to which attention is directed above has been issued by the British Broadcasting Company and relates alone to the conditions to be fulfilled by the receiving sets which are to be offered for sale to the public by members of that corporation. No declaration has so far been made by the Post Office which in any way indicates that the Postmaster-General contemplates the adoption of a policy at variance with that which he informed Parliament it was his intention to pursue in this matter; nevertheless, it is distinctly unfortunate that, in all the circumstances of the case, an official statement has not been issued by the Post Office setting out fully and frankly what course it is intended to pursue in relation to the grant of licences generally.

THE assignment to science of the proceeds of the first performance of a great play by a leading dramatist is an act which we record with much satisfaction. The play was the remarkable tragedy "Judith," by M. Henri Bernstein, produced at the Gymnase Théâtre, Paris, on October 12, before a brilliant and distinguished assembly, which comprised ministers of State and the chief social and intellectual leaders of the city. The Paris correspondent of the *Daily Mail* states that the receipts were for the benefit of the French Confederation of Scientific Societies, and the *Times* correspondent announces that more than 1000*l.* was raised by the performance. M. Bernstein gave his royalty as author, and Mme. Simone, who took the title part and obtained the greatest triumph of her career, devoted her fee to the same beneficent purpose. We cannot recall any like association of drama with science in Great Britain, and it is difficult to conceive of the proceeds from a first night being devoted to a scientific institution in this country. If, however, Sir James Barrie, Mr. Bernard Shaw, Mr. Oscar Asche, or any other of our leading dramatists or theatre managers should be inclined to follow the example which Paris has given us, we commend to their attention as eminently worthy of support such confederations as the British Association, British Science Guild, and the Conjoint Board of Scientific Societies.

THE August number of the *Journal of Indian Industries and Labour* contains two articles on State control in the field of industrial enterprise. Mr. C. Y. Chintamani, Minister of Education and Industries in the United Provinces, deals with the subject in an article entitled "The Limits of State Aid to Industry," with special reference to the work of the department of which he is in charge, while Mr. A. Y. G. Campbell contributes the first part of an article on the functions of provincial departments of industries in which the whole question of State assistance is reviewed. Mr. Campbell speaks from experience, as he himself held for some years the post of Director of Industries in Madras. Another feature is an extract from the presidential address delivered to the Mining and Geological Institute of India in January 1922 by Dr. Leigh Fermor, officiating director of the Geological Survey of India, in which is described the practical utility of a State geological department. Dr. Fermor declares that in royalties alone the receipts accruing annually to the Provincial Governments and other owners of mineral rights in India in respect of the eight most important minerals, excluding salt and saltpetre, amount to at least 560,000*l.* The *Journal* also contains the usual summarised accounts of the activities of the Provincial Departments of Industries during the preceding quarter.

THE council of the Institution of Mining and Metallurgy has awarded the Gold Medal of the Institution to Sir Alfred Keogh, "on the occasion of his retirement from the Rectorship of the Imperial College of Science and Technology, in recognition of his great services in the advancement of technological education and as a mark of admiration and respect." The council of the Institution of Mining Engineers has awarded the Medal of the Institution to Sir George Beilby, "in recognition of his valuable contributions to science, with special reference to his researches on fuel." The medals will be presented at the combined dinner of the two institutions to be held at Guildhall, London, on November 16, at which the Prince of Wales and several ministers of State will be present.

DR. M. O. FORSTER was entertained at dinner by a number of his chemical friends on October 6 on the eve of his departure to India to take up the duties of his new appointment as director of the Indian Institute of Science at Bangalore. He left England on October 13 by the P. and O. steamship *Morea.*

IT is stated in the *Chemiker Zeitung* of September 14 that Prof. Wieland has been appointed to the editorial board of *Liebig's Annalen* in place of the late Prof. Wislicenus. The board consists, in addition, of Profs. Wallach, Graebe, Zincke, and Willstätter. In the issue of September 26 it is announced that Dr. Noddack has been appointed director of the Physikalisch-Technische Reichsanstalt.

AT the inaugural meeting of the eighty-first session of the Pharmaceutical Society's School of Pharmacy, Bloomsbury Square, on October 4, the Hanbury medal, awarded every two years for the promotion of research in the chemistry and natural history of drugs, was presented to Prof. Emile Perrot, professor of materia medica in the University of Paris.

THE fifth annual Streatfeild Memorial Lecture will be delivered by Prof. C. H. Desch in the Chemical Lecture Theatre of the Finsbury Technical College, Leonard Street, E.C.2, on Thursday, November 2, at 4 o'clock. The subject will be "The Metallurgical Chemist."

THE forty-fifth anniversary of the Institute of Chemistry will be celebrated by a dinner to be held at the Hotel Victoria, Northumberland Avenue, W.C.2, on Friday, November 17.

ON Tuesday, October 10, members of the Circle of Scientific, Technical, and Trade Journalists accepted the invitation of Holophane Ltd. to visit the new showrooms and laboratories, where an address was delivered by Captain Stroud, and a demonstration of the latest scientific devices for distributing artificial light was arranged. In addition to standard types of reflectors for use in streets, factories, shops, etc., several interesting novelties were shown, including the new unit equipped with Chance's daylight glass to produce "artificial daylight." The appearance of coloured surfaces under this light, as compared with that of ordinary electric lamps, was demonstrated in the laboratory, where apparatus for obtaining polar curves of light distribution was also shown in operation. Mr. Leon Gaster, in returning thanks on behalf of the visitors, remarked that the scientific application of light was a subject of general interest to the technical press. Its importance was illustrated by the appointment, in 1913, of a Home Office Committee on Lighting in Factories and Workshops. It was hoped that in future each scientific advance would be brought to the notice of the technical press, which acted as an educational link between the expert and the general public.

THE seventy-sixth annual meeting of the Birmingham and Edgbaston Debating Society was held on October 4. The visitors included Alderman David Davis (Lord Mayor of Birmingham), Dr. R. Wakefield (Bishop of Birmingham), Dr. McIntyre (Archbishop of Birmingham), Mr. C. Grant Robertson (principal of Birmingham University), Mr. C. A. Vince (president of Birmingham Central Literary Association), and Mr. Arthur Brampton (president of Birmingham Liberal Association). Mr. G. Austin Baker was elected president for the ensuing session. Mr. Harry Jackson, the retiring president, delivered an address on "The Trend of Human Development." He showed that whereas in the past the environment and progress of man was limited to tangible things, to-day it extends more and more to regions outside the immediate perceptions of the senses. The views of Einstein, as contrasted with those of Newton, are a typical example and represent a great and intrinsic mental advance. The individual with the supersensitive faculty in some particular direction must be given the scope and opportunity for the full expression of his genius. Humanity cannot afford to let clever men wear out their genius in providing themselves with the necessities of life. The most advantageous application of national wealth will be the maintenance of those who are able to work in the higher environment of the intellect.

MR. A. RADCLIFFE BROWN has sent us a long letter complaining of the review of his book—"The Andaman Islanders"—in NATURE of July 22, p. 106. The gist of the reviewer's criticism was that Mr. Brown spoilt a good plan—namely, of stating his own observations and where they differed from those of his chief predecessor, Mr. E. H. Man—by so carrying it out as to lead the reader to suppose that Mr. Man's work was not worth much. Mr. Brown's defence is that in adopting his plan of procedure he was obeying the instructions of the Anthony Wilkins Studentship, under whose auspices his work was undertaken. The reviewer did not complain of the plan but of the method of carrying it out. Next, with regard to the reviewer's criticism of the unwisdom of adopting the *Anthropos* Alphabet of Pater Schmidt for his work in supersession of the long-established alphabet compiled by so competent an authority as Mr. A. J. Ellis, Mr. Brown writes that he has "no hesitation in accepting the *Anthropos* Alphabet as the nearest approach possible at the present time to a scientific universal alphabet." But at the same time he quotes the fact that Sir Richard Temple published a universal grammar which has not been adopted to any extent by other writers, "doubtless because of the objection they feel to giving up the system of grammar to which they are accustomed." Mr. Brown, having thus the fate of Sir Richard Temple's grammar before him and appreciating the reason for it, might have been warned of the fate awaiting the *Anthropos* Alphabet, and that the only result in the circumstances of partially adopting it in a work, which he himself says "does not deal with the languages of the Andamans," would be to puzzle, and not enlighten, the student. To the reviewer's criticism of use being made without acknowledgment of information gathered by living predecessors, Mr. Brown raises the defence that any passages bearing such an interpre-

tation must have occurred in the introduction "which was meant as such and nothing more." It certainly does not justify the "correction" of the work of highly experienced local officials with not only the people and the country before them, but also the possession of the official technical works and some of the other general books, on which Mr. Brown relies for his facts.

IN a book entitled "Science and Human Affairs," which Messrs. George Bell and Sons, Ltd., will shortly publish, the author, Dr. W. C. Curtis, will recount how the conveniences of daily life and the safeguards to health have been discovered, and the possible bearing of science on human affairs in the future.

THE following catalogues, which should be useful to readers of NATURE, have just reached us: No. 95 (of Botanical and Zoological Works) from Messrs. Dulau and Co., Ltd., 34 Margaret Street, W.1; No. 216 (of Periodicals, Collections, Transactions, and Publications of Learned Societies, etc.) from Messrs. W. Heffer and Sons, Ltd., Cambridge; and No. 372 (miscellaneous, including Natural and Physical Sciences) from Messrs. Bernard Quaritch, Ltd., 11 Grafton Street, W.1.

MESSRS. LONGMANS AND CO. have in preparation, in four volumes, "A Natural History of the Ducks," by Dr. J. C. Phillips, of the Museum of Comparative Zoology, Cambridge, Mass., U.S.A., which will aim at giving an exact and detailed description of all known species of ducks, mapping their breeding and migration ranges. It will also contain full life-histories of the European and American species. The work will be illustrated in colour and in black and white by F. W. Benson, A. Brooks, and L. A. Fuertes. Vol. 1 is nearly ready for publication.

SIR RONALD ROSS is bringing out, through Mr. John Murray, a work entitled "The Great Malaria Problem and its Solution: an Autobiographical Account," which will give a complete history of the discovery of the relation between malaria and mosquitoes, showing how malaria is carried from man to man. Another book in the same publisher's announcement list is "Gardening for the XXth Century," by C. Eley, in which attention is chiefly directed to the more permanent features in gardens. The work will contain a list of selected trees and shrubs, with descriptive and cultural notes, and brief chapters upon botany and nomenclature.

Our Astronomical Column.

MERCURY VISIBLE AS A MORNING STAR.—Mercury will reach its greatest elongation, 18° 38′ west, in the early morning of October 31, and will be visible before sunrise during the period from about October 22 to November 10. The planet will rise about $1\frac{3}{4}$ hours before the sun, and should be easily visible about an hour before the times of sunrise. Its position will be near the horizon in E. by S., and it will shine with a rosy, fluctuating light about equal to that of a first magnitude star.

The planet Saturn will be very near Mercury on about October 23, when the distance separating the two orbs will be a little more than 2°.

Telescopic observations of Mercury are much required, the exact time of the planet's rotation being doubtful. It is a good plan for those observers who do not possess equatorial telescopes to pick up the planet when it is visible to the naked eye, and to get and retain the disc in the field of view of the instrument until some time after sunrise, when it will have risen sufficiently high above the vapours near the horizon to permit the image to be well defined. Mercury certainly presents dusky markings which are capable of being followed when clear weather allows, and the planet offers a much better prospect for successful scrutiny than Venus.

COMETS.—Perrine's periodic comet, 1896 VII. and 1909 III., should now be looked for in the moon's absence. The following ephemerides are on two assumptions of the time of perihelion:

Date. Greenwich Noon.	Assumed T., Oct. 3. R.A. h. m.	Decl.	Assumed T., Oct. 11. R.A. h. m.	Decl.
Oct. 19.0	7 45	19°·0 N.	7 19	24°·0 N.
27.0	8 5	14°·3	7 40	18°·7
Nov. 4.0	8 21	9°·6	7 56	13°·4
12.0	8 33	5°·1 N.	8 9	8°·1 N.

Search should be made near the line joining the two positions for each date.

Mr. Wood sends the following elliptical orbit of comet 1922 *a*:

EPOCH 1922, JAN. 1.0.

M	0° 2′ 1″
ω	183° 37′ 32″
Ω	274° 30′ 13″
i	32° 30′ 16″
log e	9·9953713
log a	2·1874524
μ	1″·857

Period about 1900 years.

Mr. Wood is at work on a more exact orbit, using photographic positions that extend to April 25 last.

THE MASSES OF VISUAL BINARY STARS.—The *Astronomical Journal*, No. 807, contains measures of the parallaxes of several binary stars made photographically at the Sproul Observatory by Messrs. J. A. Miller and J. H. Pitman. Investigation was made as to how far the irregularity of the combined image and the change in relative positions due to orbital motion between the exposures might introduce error. The probable errors seem to be quite as small as for single stars. The parallaxes deduced by other observers are tabulated as well as their own, and masses are deduced and classified according to spectral type with the following results for average mass: B 14·91; A 3·49; F 3·92; G 1·77; K 1·57; M 0·65. Only two M stars were available.

In conclusion, the advisability is pointed out of obtaining absolute parallaxes of as many binaries as possible by the relative shift of spectral lines due to different motion of the components in the line of sight. The method has already been applied to Alpha Centauri and to Castor, also to Sirius (bright star only). A list is given of 18 stars to which the method might be applied, with the amount of present and maximum differential motion. It is necessary either that both spectra should be visible or that the relative masses should be known.

Research Items.

GYPSY FOLKLORE.—The new series of the Gypsy Lore Society's Journal is being actively conducted by its energetic secretary, Mr. T. W. Thompson. The last issue (Third Series, vol. i., part 3) contains an excellent article by him on the Gypsy Grays as tale-tellers, which describes the methods by which the incidents of their stories are manipulated. This has a much wider interest than is implied by its title, and students of folk tales will find that it throws much needed light on the construction of these narratives.

HOCKEY IN ANCIENT GREECE.—An ancient Greek sculptured relief recently discovered in Athens, according to the *Times*, gives evidence that the Greeks played ball games other than with the hand. The relief represents six naked youths taking part in a game bearing every resemblance to modern hockey. The curved stick used may possibly supply an explanation of the singular curved object carved in relief on some of the votive offerings found at Sparta. These have been called "sickles." It is difficult to say why this implement should have been dedicated to Artemis, but the word "sickle" may have been the current slang for a boy's hockey-stick.

ROMAN REMAINS IN LONDON.—Recent excavations in the City have led to important discoveries. It seems to be proved that the ancient church of St. Peter's-upon-Cornhill was built inside of what was once a Roman fortress, which future investigation is expected to show was the first fortified camp of the Romans. If so, it is possible that it was built immediately after the re-establishment of order subsequent to the revolt of Boadicea. Mr. W. C. Edwards, the archæologist in charge of these investigations, believes that during the next ten years more Roman discoveries will probably be made in the City than have been made for centuries. The excavation recently struck what is probably the most ancient wall yet found in London. At one point it is 5 feet thick, and above the footings were courses of tiles, four abreast, each 13 inches broad. Rooms were added to it with plastered walls which appear to be of imitation alabaster, the wall being overlaid with a layer of white cement, almost as thin as paper, on which designs had been painted by a very skilful artist. It is now clear that Gracechurch Street was not Roman: it probably belongs to Saxon times, and was the work of Alfred the Great.

ARCHÆOLOGY IN PALESTINE.—Among the obligations undertaken by Great Britain in connexion with the control of Palestine is that of promoting archæological research. It was a condition of the scheme that in the Advisory Board for Archæology other nations should be represented. The first work which will now be undertaken is the excavation of the ancient City of David on Mount Ophel, immediately south of the existing walls of Jerusalem. Three different attempts have been made to probe the secrets of the hill, and though attended with some measure of success, practically the whole of Jebus, the original stronghold, the Palace and Millo of David, and in all probability the tombs of the Kings of Judah, await investigation. An area of ten acres has been preserved by the Administration, and this is now available for excavation. East of Jordan an immense field remains practically untouched, and many of these sites are of importance equal to that of Palestine itself. Especially at Jerash, the ancient Gerasa, there are wonderful remains of the Roman city, which show that it was one of the most imposing cities of the Roman period. The excavation of these Palestine sites is likely to throw welcome light not only on the history of the Hebrews but on the obscure annals of the nations who preceded them, and it may be hoped that the Palestine Exploration Fund, which counts among the names of its illustrious servants that of Kitchener, will receive adequate support in carrying out the well-arranged programme of investigation which is now laid before the scientific world.

UPPER CRETACEOUS GASTROPODS OF NEW ZEALAND.—Certain Upper Cretaceous gastropods of New Zealand, originally referred to Mr. H. Woods for description, were on his recommendation forwarded to Dr. O. Wilckens, then at Strasbourg, to deal with. The intervention of the war and consequent removal of Dr. Wilckens to Bonn delayed the completion of the task, and the finished monograph as rendered into English by the author himself has recently been issued as Palæontological Bulletin No. 9 by the Geological Survey Branch of the New Zealand Department of Mines. The major portion of the fossils studied are of Upper Senonian age. While these include a few species peculiar to New Zealand, resemblances can be traced in many examples to species from beds of equivalent age in North Germany, Chili, Patagonia, the Antarctic Regions, and South India. Of the indigenous forms the most striking is the remarkable *Conchothyra parasitica*, and Dr. Wilckens gives a very careful account of its strange growth and development. The plates accompanying the monograph are deserving of much praise, and there is a map showing the localities whence the fossils were obtained.

MARINE FOSSILS IN CENTRAL INDIA.—The General Report of the Geological Survey of India for 1921 contains a confirmation, and some further particulars, of the discovery of marine fossils in the lower Gondwana series of Central India, which was reported in some of the Indian newspapers about nine months ago. The discovery, which was made by Mr. K. P. Sinor, State Geologist to the Rewah Durbar, at Umaria, situated almost centrally in the broadest part of the Peninsula, consists of a shell band, about 3 inches thick, composed almost entirely of shells of the genus Productus. Below the shell band are quartz grits which pass up, through the band, conformably into sandstones of Lower Barakar age, the bed itself lying not far from the junction of the Gondwana rocks with the underlying gneiss, in beds which are usually regarded as of Talchir age. The discovery has been further investigated by Mr. P. N. Mukherji, field collector of the Survey, who added two specimens of Spiriferina to the fauna. The Productus has not yet been identified, but it is new to India; the Spiriferina is close to, and probably identical with, *S. cristata*, var. *octoplicata*. The fossils, therefore, are not of great assistance in determining the precise age of the band, but the discovery of marine conditions in the centre of the Peninsula, where no marine rocks of later than probably pre-Cambrian age had previously been found, is of great interest and importance. Dr. L. L. Fermor, the officiating director, by whom the report is made, discusses the question of whether the sea lay mainly to the north, or the west, of the newly discovered Productus locality. In either case the discovery, though of interest as marking a greater extension of the sea than had been previously suspected, does not materially alter the conclusion that the Indian Peninsula is a region which has been continuously dry land throughout the whole period covered by the sequence of fossiliferous rocks.

THE DISTRIBUTION OF TEMPERATURE IN SCANDINAVIA.—The Meteorological Institute of Sweden has published an important paper and series of charts by Mr. H. E. Hamberg on thermosynchrones and thermoisochrones in the Scandinavian peninsula (*Bihang till Meteorologiska lak ttagelser, Bd.* 60, 1918 (1922)). In tables and charts, founded on the observations of 232 Swedish and 83 Norwegian stations, Mr. Hamberg gives the mean annual dates at which certain temperatures reign. The temperatures are reduced to sea-level for this purpose, although Mr. Hamberg fully realises that for certain geographical uses the value of the charts is thereby lessened, and he gives two pairs of charts, spring and autumn, one for 12° C. and the other for 0° C., in which the actual temperatures are utilised. A second series of charts indicates the average number of days with a temperature above or below certain figures. The curves on these charts Mr. Hamberg terms thermoisochrones. The charts, which are small but very clear, are most useful for geographical purposes.

SPELL OF WARM WINTERS IN EUROPE.—The abnormal winter warmth recently experienced in Central Europe, embracing England, is dealt with in the *Meteorological Magazine* for September by Mr. C. E. P. Brooks, of the Meteorological Office. A chart is given showing the differences of the mean temperatures for the winter, comprised by the months December, January, and February, for the years 1911 to 1920, and the long period averages for the combined winter months, mostly covering the years 1851 to 1910. At Budapest the winters of the past ten years have on the average been more than 4° F. warmer than the normal winter. At Zürich the excess is 2°·6 F.; at Paris, 2°·1 F.; and at Kew, 1°·8 F. On the Atlantic sea-board the winters of the decade in question have been slightly colder than the normal. There is no appreciable difference of temperature for the rest of the year, the summer months for the years 1911 to 1920 having been, on the whole, somewhat cooler than the average. The abnormal warmth of the winters was not confined to low levels; the mean winter temperature for the ten-year period at St. Gothard, 6877 feet above sea-level, is 1°·9 F. above the normal. The author suggests a tentative explanation connecting the abnormal warmth with the general decrease of sunspot numbers since the nineteenth century. Taking the mean winter temperature at Greenwich for the ten-year period, 1911 to 1920, it is 1°·5 F. above the 60 years' average, and the mean was above the normal in 8 winters out of 10, the excess being more than 3° F. in 4 winters. In the ten-year period from 1886 to 1895 the mean winter temperature at Greenwich was 1°·9 F. below the normal for sixty years, and in 8 winters out of 10 the mean was below the average, the deficiency amounting to 3° F. or more in 3 winters; this is a different period from that given by the author and with an opposite effect.

GLARE FROM MOTOR HEADLIGHTS.—The descriptions of motor headlights exhibited at the meeting of the Optical Society on May 11 will be found in part 4 of volume 23 of the Transactions of the Society, together with a report of the discussion of the conditions which a satisfactory headlight should fulfil. In America these conditions are that 100 feet ahead of the car at a point 5 feet above the horizontal, the illumination must not exceed that due to a lamp of 750 candle power. The conditions laid down in this country by the Ministry of Transport relate to the width and height of the beam and place no restriction on its intensity. The reconciliation of the requirements of the driver and the pedestrian or driver he is approaching is difficult, but the general opinion of those who took part in the discussion appeared to be that the beam should have a candle power of 3000 in a direction half a degree below the horizontal and be reduced to 500 or 600 candle power in a direction one degree above the horizontal. As the glare effect is due to contrast, it was further suggested that the car body and the road at the side of the car should be illuminated to some extent as well as the road in front.

A NEW THEORY OF VISION.—A photo-electric theory of vision has recently been put forward by Dr. F. Schanz of Dresden and has been discussed in the *Zeitschrift für Augenheilkunde.* At present it is incomplete, but according to a paper in vol. 54 of the *Zeitschrift für Sinnesphysiologie* the author hopes to fill in the gaps by work on which he is at present engaged. In outline it is as follows: Light on entering the eye is absorbed by the visual purple, which as a result emits electrons at speeds which depend on the wave-length but not on the intensity of the incident light; that is, the visual purple is photo-electric. The electrons impinge on the rods and cones and produce the sensation of light. If their velocities do not differ widely they are equalised during their passage to the rods and cones and produce a single sensation corresponding to the mean velocity; but if they differ materially the interval between their emission and their arrival at the rods and cones is not sufficient to equalise them and they produce distinct sensations. Over a range of wave-lengths of 1×10^{-4} cm. equalisation is produced, but if all wave-lengths over a range double this are present, the sensation of white is produced, whether the range be *e.g.* from 4 to 6 or from 6 to 8×10^{-4} cm.

TESTING FOR VITAMINS.—Investigators are searching actively for some chemical means of recognising the presence of the vitamins in food materials, and the discovery of such a test would enormously increase the facility of research on these elusive substances. So far all the suggestions made have failed to withstand a critical examination. In a recent paper in the *Analyst*, Messrs. Drummond and Watson point out the close relation which exists between the presence of vitamin A in fats and the well-known reaction given by liver oils, which consists in the production of a purple coloration when the oil is dissolved in an organic solvent and a drop of sulphuric acid is added. All the liver oils of mammals, birds, and fish examined by the authors gave the reaction, but they also find that it is given, although less strongly, by the body fat of some animals and by butter. In striking agreement with the behaviour of vitamin A, the power of producing the coloration is lost when a current of air is passed through the fat at 100° C. but not when the fat is heated at this temperature in absence of air. Again, when the fat is hydrolysed it remains, with the vitamin A, in the unsaponifiable fraction. Moreover, the intensity of the reaction was found to be roughly proportional to the vitamin A content of a series of fish-liver oils. The livers and fat of pigs and rats fed on diets deficient in vitamin A did not give the reaction, but this reappeared when the deficiency was made good. It is obvious that there is a close parallel between the two properties, and the authors, without claiming that the test actually indicates the presence of the vitamin, suggest "that the association may be of some significance." The necessity for this caution is indicated by the facts that although the marine diatom Nietzschia has been shown to be rich in vitamin A the oil extracted from this organism did not give the purple colour test with sulphuric acid. A similar negative result was obtained with plankton oil, although the reaction was given by certain marine algæ.

Tendencies of Modern Physics.

THE Swiss Society of Natural Sciences met this year at Berne on August 24 to 27. The programme of the session comprised several discussions on questions of general interest, and papers of a more special character communicated to the various sections. The work was divided between the following sections: (1) Mathematics; (2) Physics; (3) Geophysics, Meteorology, and Astronomy; (4) Chemistry; (5) Geology, Mineralogy, and Petrography; (6) Botany; (7) Zoology; (8) Entomology; (9) Palæontology; (10) Anthropology and Ethnology; (11) Medical and Biological Science; (12) History of Medicine and Natural Science; (13) Veterinary Science; (14) Pharmacy; (15) Engineering History.

We cannot give here a detailed account of this annual event in Swiss science; we shall therefore confine ourselves to a résumé of the address of Prof. C. E. Guye, of Geneva, in opening the series of general discussions.

Taking the title, "The Tendencies of Modern Physics and the Conception of Matter," Prof. Guye first showed that modern physics was becoming more and more electromagnetic, discontinuous, and statistical. To these three characteristics, which have been sufficiently disconcerting to minds accustomed to the classical conceptions of the second half of the nineteenth century, there has now been added a fourth, of still more perplexing character, in the introduction of the principle of relativity. In adopting this principle physics has displayed a distinctly metaphysical tendency, which sometimes ventures to introduce into scientific discussion a dogmatic method of procedure. It is true that the difficulty is compensated by important advantages, resulting from the fact that the formulæ of relativity introduce more simplicity in the dynamics of very great velocities, and more unity between the various branches of physics.

After having shown how physics, like chemistry, has moved steadily along the path of discontinuity by the introduction of the atom of electricity and the theory of quanta, Prof. Guye spoke of the consequences of this discontinuity, which complicated greatly the explanation of phenomena apparently of the most simple character.

How, indeed, could one follow, by means of the equations of mechanics, the reciprocal actions of a nearly innumerable group of discontinuous elements (molecules, atoms, electrons)? This extreme complication which characterises the phenomenon, apparently so simple, when it is desired to study it intimately, led to the introduction of kinetic theories. The calculus of probabilities then came to the aid of physicists, powerless as they were to solve, by means of the equations of mechanics, the inextricable problems which were proposed to them. But the consequence of these kinetic theories is to lead us to conceive physico-chemical laws as statistical, so that we must picture physico-chemical determinism as a statistical determinism, to which the law of great numbers imparts all the appearance of infinite precision.

The progress of physics towards electromagnetism is particularly striking. The first decisive step along this path was made by Maxwell, to whom we owe the electromagnetic theory of light, which, universally accepted as it is to-day by physicists, unites in a systematic whole the phenomena of light and of electromagnetism. But this tendency to explain physical phenomena by the laws of electromagnetism has only served to make it still more accentuated. It has even attacked the mechanics which seemed to be the immutable basis of the old physics. To-day the fundamental postulate of mechanics—inertia—can be satisfactorily explained in terms of the properties of an electromagnetic field, and more and more intermolecular forces appear to be of electromagnetic nature (Debye, Keesom).

But the main reason for this constant evolution of physics towards electromagnetism is the work carried out particularly in England (Rutherford's school), which has exhibited it in a most convincing fashion. The material atom itself appears to be constituted entirely of charges of electricity, positive and negative (electrons), and all physical forces, with the exception of the mysterious force of gravitation, will thus be found, in the last resort, to be electric and magnetic forces.

In the second part of his address, Prof. Guye showed how the conception of matter, as defined by inertia, had evolved from Lavoisier to Einstein, and to the most recent work of Rutherford and Aston. Without committing ourselves positively to Prout's hypothesis, which would make the atomic weights of the elements integral multiples of that of a unique constituent—the atom of hydrogen—new developments point to a duality of ultimate material, the positive electron which is mainly responsible for the inertia of the atom, and the negative electron.

In short, the startling progress realised in physics during the last thirty years has reduced to naught all those fluid phantoms which we knew—imponderable electric and magnetic fluids; only the most tenacious among them—the aether—offers still a partial resistance.

Physicists have thus been led, little by little, to the idea of the materiality of electricity, and still more the formulæ of relativity point to the parallelism between inertia and energy; that is, to the fusion into a single principle of the two principles which govern all physical phenomena—the principle of the conservation of mass and that of the conservation of energy.

Such are the important results, not only from the scientific point of view, but also from that of our best philosophic culture, which modern research has brought forward during the course of the last thirty years.

The Isothermal Frontier of Ancient Cities.[1]

THE northern frontier of the Roman Empire is shown in atlases of ancient geography, and that of the Achæmenian Empire of the Persians and of the dynasties which succeeded in the Middle East. The frontier of the ancient Chinese Empire has not been made similarly familiar, and in place of it there is the representation of the Empire of China as it has been in mediæval and modern times. From this most of Manchuria, all Mongolia, and the Ili valley must be shorn off in order to get the Chinese northern frontier as it was under the Han dynasty in the beginning of the second century after Christ, the age of the Antonines in Europe. At this time, when the ancient civilisation of Eurasia was at the height of its culture and apparently at the maximum of its power, the northern frontier once controlled by

[1] Abstract of a paper by Dr. Vaughan Cornish read before Section E (Geography) of the British Association at Hull on Sept. 12.

the Persian Achæmenidæ was divided between the Parthians, capitalled at Ctesiphon, and the Kushan dynasty of the Yue-chi, capitalled at Peshawar. These four northern frontiers, Roman, Parthian, Kushan, and Chinese, were consecutive, forming an unbroken line from the mouth of the Rhine near the modern Katwyk in Holland, 52° N., to the east coast of Korea in about 41° N. South of the line a vast array of established cities stretched for seven thousand miles across Eurasia, in some parts protected by natural barriers, in others defended by lines of masonry fortification. North of the line were the tents of nomads, huts of forest dwellers, and stockaded defences of earth and wood. In the northern part of modern Germany there were territories north of the line which the Romans had abandoned as untenable or unprofitable. South of the line in Eastern Europe was the district of Dacia which Augustus preferred not to touch, but Trajan was compelled to occupy. In this country the native people had in the interval begun to construct masonry fortifications.

In the course of an investigation of the geography of capital cities, it was found that this northern frontier of ancient cities, on the eve of the barbarian irruption, has, within narrow limits of variation, the same average temperature throughout. It is a true annual isotherm, not an isotherm reduced to sea level. Along the European part is a line of modern cities with meteorological observatories. The annual temperatures of eight of these, strung out along the length, has an average of 48°·6 F. Asia is not well off for meteorological records near the line on the south, and the second table consists of a list of towns mostly under Russian rule just north of the line where proper records have been kept. It will be observed, therefore, that their temperatures are rather lower than that along the frontier of the ancient cities. The average temperature of these eight towns north of the line is 47°·4 F. A very long gap in these towns occurs between Kuldja and Mukden, but the record for the Lukchun depression in Chinese Turkestan, a little south of the frontier yields a not inconsistent figure, if corrected for the general height of the surrounding country, and that of Peking is not discordant. Further east the generalised isotherm of 48°·5 F. reaches the eastern coast of Korea in about 41° N. (somewhat north of the peninsula portion of the country) which cannot be very far from the frontier of its ancient cities.

In the detached Roman possession of Britain the inner and principal line of fortification had its western terminal at Carlisle, where the temperature is 47°·8 F. Eastwards of the continent of Eurasia the conquest of the Japanese islands by their present masters was only completed at a much later date than that under consideration, but the Japanese derived their culture from ancient China (mainly through Korea) and it may therefore be significant that they were content to conquer, without colonising, Yezo, the northern island, and that what is reckoned by the Japanese as Japan proper, and is called by them "Old Japan" does not include Yezo but stops short with Honshiu, the mainland, and that the annual isotherm of 48°·5 F. traverses the strait of Tsugaru which separates Old Japan from Yezo.

The fact that the annual temperature along this immense line only varies within remarkably narrow limits cannot be reasonably contested. If it be the case that desiccation has occurred generally in Asia along this line since the second century of our era its probable effect would be to lessen the winter and raise the summer temperature, leaving the annual temperature much the same.

The coincidence of frontier and true isotherm is not a mere consequence of east and west barriers of mountains, inland seas, and rivers, for these had to be supplemented by long lines of fortification. Neither was it due to unsuitability of the southern country to pastoral peoples, for in Asia there was much coveted grazing land south of the settled frontier. Precisely how far this coincidence is significant it is yet difficult to say.

Annual Temperatures along the Frontier in Europe.	° F.	Annual Temperatures north of the Frontier in Asia.	° F.
Carlisle	47·8	Stavropol	47
Utrecht	47·8	Astrachan	50
Cologne	50·2	Kazalinsk	46·5
Ratisbon	46·6	Aulieata	51·5
Vienna	48·8	Narynsk	44
Buda-Pesth	49·8	Vyerni	46·5
Debreczin	49·3	Kuldja	48·5
Odessa	48·5	Mukden	45
Mean	48·6	Mean	47·4

The Mechanism of the Cochlea.

MOST medical students have probably felt that current physiological teaching provided them with only a hazy conception of the mechanism for hearing in the cochlea. Helmholtz put forward the view that this organ contained a series of resonators, which were differentiated like a set of piano strings, so that each string vibrated only in response to one particular note. It will be remembered that the cochlea forms a spiral, which when unwound consists of two chambers, placed one above the other, and separated by the basilar membrane. At one end (the base) of the cochlea, in the wall of the upper chamber, is the window which is set in vibration by the middle ear, while in the wall of the lower chamber is a similar window whose function is to prevent the pressure from changing inside the cochlea when the upper window moves. Both chambers contain fluid, and, at the other end (the apex) of the cochlea, the chambers unite, for the basilar membrane ceases just short of the apex.

The suggestion that the fibres of the basilar membrane can act as a resonating system has been current since it was pointed out that their length (measured across the canal) varied continuously from the base to the apex. Now the fibres of a resonating system must obey the laws which govern vibrating strings, so that n, the number of vibrations of a string per sec., $=\frac{1}{2l}\sqrt{\frac{t}{m}}$, where l is the length of a fibre, t is the tension, and m is the mass per unit length. Gray showed in 1900 that the tension of the fibres of the basilar membrane also varied from the base to the apex, for while the spiral ligament which attached the membrane to the outer wall of the cochlea was very dense near the base, it was, on the contrary, very slender near the apex. We know, therefore, that the fibres of the basilar membrane are differentiated for tension and length, so that the short fibres near the base are under high tension, and the long ones near the apex are under low tension. To complete the requirements of the formula for vibrating strings, it is only necessary to discover a system by which the fibres are differentiated for mass, which differentiation must, as the formula

demands, be applied so that the load on the fibres is small near the base, but large near the apex.

A great difficulty in supposing that the basilar membrane represents a system of resonating strings is the fact that it is immersed in fluid. It is precisely this point which Dr. George Wilkinson, in a paper read before the Section of Physiology of the British Association at the recent Hull meeting, conceives to be, not a difficulty, but the key of the whole problem. He suggests that the differentiation of the fibres as to mass, or the "loading" of the fibres, is brought about by the fluid in the canals. When the fibres at any point of the membrane vibrate in response to an impulse from the middle ear, they will be loaded by the weight of a column of fluid proportional to the distance of the vibrating point from the *fenestra rotunda*, which is the window between the cochlea and the middle ear. The column of fluid between the window and the vibrating point will be least in the case of a point on the membrane near the base of the cochlea, and greatest in the case of a point near the apex.

So much for Dr. Wilkinson's theoretical conception. He has provided a convincing proof of his views in the shape of two very ingenious models. The first is a brass box divided horizontally into two like the cochlea unwound from its spiral. The partition which represents the basilar membrane consists of a series of parallel wires of phosphor-bronze soldered firmly in position, and covered with formalised gelatin. On this basilar membrane is scattered blue enamel powder. There is a *fenestra rotunda* and *ovalis* at one end of the box, respectively above and below the basilar membrane, the windows being formed in each case by a rubber disc. The box is filled with water and is completely closed. In his first model, Dr. Wilkinson has kept all his phosphor-bronze wires at the same tension and of the same length. Yet he finds that when he applies a vibrating tuning-fork to the rubber membrane, or *fenestra rotunda*, the powder on the basilar membrane takes up a definite position which varies with tuning-forks of different rates of vibration. Thus a 200 D.V. fork produces a localised resonant response at a distance 3·3 cm. from the proximal end of the scale, while a 400 D.V. fork produces such a response at a distance of 0·9 cm. If one makes use of the formula for vibrating strings and supposes that the differentiation in resonance is due to the different loading of the wires by the fluid according to the above hypothesis, then the point of resonance to the lower tone should be 4 times the distance from the windows compared with that for the upper tone. Actually we see that it is not 4 times, but is $3{\cdot}3/0{\cdot}9 = 3{\cdot}6$ times. A very striking agreement!

Here then is proof of Dr. Wilkinson's contention that a system of transverse fibres, immersed in a fluid as it is in the cochlea, is already, by reason of the position of the *fenestræ*, differentiated for resonance in regard to the effective mass of the fibres.

In his second model, which is larger, he has carried out a differentiation of his phosphor-bronze wires in respect of tension and length. The differentiation of tension is effected by attaching weights of different sizes to the ends of the individual wires; while the lighter weights are attached to the longer fibres near the "apex," the heavier weights are attached to the shorter fibres near the base. In this way he has attained a model which gives a localised resonant response over a range exceeding four octaves.

One may say in conclusion that Dr. Wilkinson has made a very considerable contribution to our knowledge of the mechanism of hearing, and has presented the first clear conception of how the cochlea can work.

British Association Research Committees.

RESEARCH committees to deal with the following subjects were appointed by the General Committee at the recent meeting of the British Association at Hull. The names given are those of the chairmen and secretaries of the committees.

SECTION A (MATHEMATICS AND PHYSICS).—Seismological investigations: Prof. H. H. Turner, Mr. J. J. Shaw. To assist work on the tides: Prof. H. Lamb, Dr. A. T. Doodson. Annual tables of constants and numerical data, chemical, physical, and technological: Sir Ernest Rutherford, Prof. A. W. Porter. Calculation of mathematical tables: Prof. J. W. Nicholson, Dr. J. R. Airey. Determination of gravity at sea: Prof. A. E. H. Love, Prof. W. G. Duffield. Investigation of the upper atmosphere: Sir Napier Shaw, Mr. C. J. P. Cave. To aid the work of establishing a solar observatory in Australia: Prof. H. H. Turner, Prof. W. G. Duffield.

SECTION B (CHEMISTRY).—Colloid chemistry and its industrial applications: Prof. F. G. Donnan, Dr. W. Clayton. Absorption spectra and chemical constitution of organic compounds: Prof. I. M. Heilbron, Prof. E. C. C. Baly.

SECTION C (GEOLOGY).—The Old Red Sandstone rocks of Kiltorcan, Ireland: Prof. Grenville Cole, Prof. T. Johnson. To excavate critical sections in the palæozoic rocks of England and Wales: Prof. W. W. Watts, Prof. W. G. Fearnsides. The collection, preservation, and systematic registration of photographs of geological interest: Prof. E. J. Garwood, Prof. S. H. Reynolds. To consider the preparation of a list of characteristic fossils: Prof. P. F. Kendall, Mr. H. C. Versey. To investigate the flora of lower carboniferous times as exemplified at a newly discovered locality at Gullane, Haddingtonshire: Dr. R. Kidston, Prof. W. T. Gordon. To investigate the stratigraphical sequence and palæontology of the Old Red Sandstone of the Bristol district: Mr. H. Bolton, Mr. F. S. Wallis.

SECTION D (ZOOLOGY).—To aid competent investigators selected by the committee to carry on definite pieces of work at the Zoological Station at Naples: Prof. E. S. Goodrich, Prof. J. H. Ashworth. To summon meetings in London or elsewhere for the consideration of matters affecting the interests of zoology, and to obtain by correspondence the opinion of zoologists on matters of a similar kind, with power to raise by subscription from each zoologist a sum of money for defraying current expenses of the organisation: Prof. S. J. Hickson, Dr. W. M. Tattersall. Zoological bibliography and publication: Prof. E. B. Poulton, Dr. F. A. Bather. Parthenogenesis: Prof. A. Meek, Mr. A. D. Peacock. To nominate competent naturalists to perform definite pieces of work at the Marine Laboratory, Plymouth: Prof. A. Dendy (*Chairman and Secretary*). Experiments in inheritance in silkworms: Prof. W. Bateson, Mrs. Merritt Hawkes. Experiments in inheritance of colour in Lepidoptera: Prof. W. Bateson (*Chairman and Secretary*).

SECTION E (GEOGRAPHY).—To consider the advisability of making a provisional population map of the British Isles, and to make recommendations as to the method of construction and reproduction: Mr. H. O. Beckit, Mr. F. Debenham.

SECTIONS E, L (GEOGRAPHY, EDUCATION).—To

formulate suggestions for a syllabus for the teaching of geography both to matriculation standard and in advanced courses; to report upon the present position of the geographical training of teachers, and to make recommendations thereon; and to report, as occasion arises, to Council, through the Organising Committee of Section E, upon the practical working of regulations issued by the Board of Education affecting the position of geography in training colleges and secondary schools: Prof. T. P. Nunn, Mr. W. H. Barker.

SECTION G (ENGINEERING).—To report on certain of the more complex stress distributions in engineering materials: Prof. E. G. Coker (*Chairman*), Prof. L. N. G. Filon, and Prof. A. Robertson (*Secretaries*).

SECTION H (ANTHROPOLOGY).—To report on the distribution of Bronze Age implements: Prof. J. L. Myres, Mr. H. J. E. Peake. To conduct archæological investigations in Malta: Prof. J. L. Myres, Sir Arthur Keith. To conduct explorations with the object of ascertaining the age of Stone Circles: Sir Hercules Read, Mr. H. Balfour. To excavate early sites in Macedonia: Sir William Ridgeway, Mr. S. Casson. To report on the classification and distribution of rude stone monuments: Dr. R. R. Marett, Prof. H. J. Fleure. The collection, preservation, and systematic registration of photographs of anthropological interest: Sir Hercules Read, Mr. E. N. Fallaize. To conduct archæological and ethnological researches in Crete: Dr. D. G. Hogarth, Prof. J. L. Myres. To co-operate with local committees in excavation on Roman sites in Britain: Sir William Ridgeway, Mr. H. J. E. Peake. To report on the present state of knowledge of the ethnography and anthropology of the Near and Middle East: Dr. A. C. Haddon, Mr. E. N. Fallaize. To report on the present state of knowledge of the relation of early palæolithic implements to glacial deposits: Mr. H. J. E. Peake, Mr. E. N. Fallaize. To investigate the lake villages in the neighbourhood of Glastonbury in connexion with a committee of the Somerset Archæological and Natural History Society: Sir William Boyd Dawkins, Mr. Willoughby Gardner. To co-operate with a committee of the Royal Anthropological Institute in the exploration of caves in the Derbyshire district: Sir William Boyd Dawkins, Mr. G. A. Garfitt. To investigate processes of growth in children, with the view of discovering differences due to race and sex, and further to study racial differences in women: Sir Arthur Keith, Prof. H. J. Fleure. To conduct excavations and prepare a survey of the Coldrum megalithic monument: Sir Arthur Keith, Prof. H. J. Fleure. To report on the existence and distribution of long-barrows in the Isle of Man: Prof. H. J. Fleure, Dr. Cyril Fox. To report on proposals for an anthropological and archæological bibliography, with power to co-operate with other bodies: Dr. A. C. Haddon, Mr. E. N. Fallaize. To report on the best means of publishing a monograph by Dr. Fox on the archæology of the Cambridge region: Dr. A. C. Haddon, Mr. H. J. E. Peake.

SECTION I (PHYSIOLOGY).—Efficiency of movement in men equipped with artificial limbs: Prof. E. P. Cathcart, Prof. A. V. Hill. Muscular stiffness in relation to respiration: Prof. A. V. Hill, Dr. Ff. Roberts.

SECTION J (PSYCHOLOGY).—The place of psychology in the medical curriculum: Prof. G. Robertson, Dr. W. Brown. Vocational tests: Dr. C. S. Myers, Dr. G. H. Miles.

SECTION K (BOTANY).—To continue breeding experiments on Œnothera and other genera: Dr. A. B. Rendle, Dr. R. R. Gates. Primary botanical survey in Wales: Dr. E. N. Miles Thomas, Prof. O. V. Darbishire.

SECTION L (EDUCATIONAL SCIENCE).—Training in citizenship: Rt. Rev. J. E. C. Welldon, Lady Shaw. To inquire into the practicability of an international auxiliary language: Dr. H. Foster Morley, Dr. E. H. Tripp.

University and Educational Intelligence.

BIRMINGHAM.—The University War Memorial, which was unveiled on Sunday, October 8, takes the form of three large panels of marble, on the eastern side of the entrance hall of the University, bearing the names of members of the University who fell in the war.

The Muirhead lectures in social philosophy are to be delivered by Prof. J. H. Muirhead, who has chosen as his subject "The Idea of Progress." The first of the series of seven is to be given on October 16. The lectures are free.

CAMBRIDGE.—The Vice-Chancellor announces a legacy of 1000*l*., free of legacy duty, to the Agricultural Department of the University by the will of the late Charles Jewell; by the will of the late Dr. Rivers books and pamphlets have been left to the library of St. John's College, and in addition 70 volumes have been selected for the library of the Psychological Department and 295 volumes for that of the Department of Ethnology.

Mr. W. J. H. Sprott, Clare College, has been appointed demonstrator in experimental psychology.

Mr. J. C. Burkill and Mr. A. E. Ingham have been elected Fellows of Trinity College.

It is proposed to confer an honorary M.A. degree on Prof. H. R. Dean.

LEEDS.—At a Congregation of the University held on Tuesday, October 10, the Duke of Devonshire, Chancellor of the University, presiding, the following honorary degrees were conferred: *Litt.D.*: The Lord Bishop of Ripon (The Rt. Rev. Dr. Thomas Banks Strong) and Mr. Bruce Richmond, Editor of the *Times Literary Supplement*. *D.Sc.*: Sir Dugald Clerk, Sir Frank Dyson, Astronomer Royal, and Sir Richard Gregory, Editor of Nature, president of the Educational Section of the British Association, 1922. *LL.D.*: Mr. H. I. Bowring, Mr. B. Broadbent, Mr. H. McLaren, and Mr. C. F. Tetley.

Sir Dugald Clerk was presented by Prof. Smithells, who said, "In him we welcome one who came to Leeds as a member of the first chemical staff of the Yorkshire College of Science, and he returns to-day a man eminent among his fellows as a great example of the ideal on which this University has spent so much of its early labours—the harmonious and fruitful union of pure and applied science."

In presenting Sir Frank Dyson, Prof. Whiddington referred to him as "the most distinguished British astronomer," who, they remembered with pride, is also a great Yorkshireman, and in his chosen field of work has been unvaryingly successful. "Every one knows him as the Astronomer Royal, a position which in these days of astronomical discovery he has filled with the highest distinction."

Prof. Smithells, in presenting Sir Richard Gregory, said: "He stands as one of the most distinguished of those who strive to interpret science to the multitude, to obliterate the false antagonisms that have arisen between the different realms of knowledge, and to win for science her rightful place among the potent influences that act for the true enlightenment and progress of mankind."

LONDON.—Dr. C. Da Fano will begin on Wednesday, October 25, at King's College, at 4.30, a course of eight free public lectures on "The Histology of the

Nervous System." The subsequent lectures will be given on November 1, 8, 15, 22, 29, and December 6 and 13. No tickets are required.

Dr. George Senter and Mr. C. W. Crook have been elected by the science graduates to fill the two vacant seats on the Senate.

SHEFFIELD.—The Council has appointed Prof. A. H. Leahy to be emeritus-professor of mathematics, and Mr. R. Platt to be demonstrator in pathology and bacteriology.

DR. A. J. SUTTON PIPPARD has been appointed professor of engineering at the University College of South Wales and Monmouthshire, Cardiff.

THE Loughborough Technical College has since 1918 developed a well-equipped faculty of engineering with departments of mechanical and civil, of electrical, and of automobile engineering. In its calendar for 1922–23 (price 3*s.* 6*d.*) it claims that its own workshops enable it to provide the student with all necessary practical training concurrently with his theoretical work, thus obviating the risk, incidental to sandwich systems, of forgetting in the works what was learned in the college and *vice versa*. The college is said to have at present more than 1500 full-time day students in residence. The governors include representatives of the universities of Birmingham and Cambridge, as well as of Leicestershire County Council and Loughborough Town Council.

THE Merchant Venturers' Technical College of Bristol, in which is provided and maintained the Faculty of Engineering of the University of Bristol, has issued for the session 1922–23 a calendar (price 6*d.*) with 18 full-page illustrations. Like the Royal Technical College, Glasgow, it is in touch with a number of engineering firms which co-operate with it in regard to the training of apprentices, but, whereas the former arranges its engineering courses in such a way as to leave student-apprentices free to spend in their firms' works the summers intervening between the winter sessions of the college, a special feature of the Bristol "sandwich scheme" is that the student spends in the works 14 months between the first and second college (10-months) sessions. Among the free-tuition entrance scholarships of the Merchant Venturers' College is one "for the son of a citizen of Béthune who has passed either the B.-ès-L. or B.-ès-Sc. examination."

THE administration of schools in the smaller cities of the United States of America is dealt with in an interesting and stimulating way in Bulletin No. 2 of 1922 of the Bureau of Education (Govt. Printing Office, Washington, D.C., price 10 cents). The statistical basis consists of answers by 520 superintendents of education to a *questionnaire*. From the section relating to teachers' qualifications it appears that the standard requirements as regards training for teaching in elementary and in high schools respectively are two years of normal-school work for the former and four years of college work with professional courses for the latter. The United States Chamber of Commerce has lately, in a pamphlet entitled "Know and Help your Schools," given currency to the view that the work of the elementary school in forming habits and ideals being as important as the work of any other school division, the elementary school teachers should be as well trained and well paid as those of the high school, but it does not appear that many school boards have as yet adopted this view.

Calendar of Industrial Pioneers.

October 22, 1915. Sir Andrew Noble died.—Widely known for his important researches on guns, projectiles and explosives, Noble was born in Greenock on September 13, 1831, and for some years served in the Royal Artillery. Joining Armstrong in 1860, he was for many years director of the ordnance works at Elswick and after Armstrong's death became the head of the great armament firm. His original investigations cover a period of fifty years, many of his memoirs being contributed to the Royal Society.

October 24, 1903. Samson Fox died.—The founder in 1874 of the Leeds Forge Company, Fox patented in 1877 his well-known corrugated furnace for steam boilers, the adoption of which led to the use of higher steam pressures. He first made pressed steel frames for railway wagons and was a pioneer of the acetylene industry.

October 25, 1684. Dud Dudley was buried.—Born in 1599, Dudley was a natural son of Edward Sutton, fifth Baron Dudley. Educated at Balliol College, Oxford, he was summoned home to superintend his father's iron works in Worcestershire, and in 1619 took out a patent for the use of pit coal instead of charcoal for smelting iron ore, an improvement in iron manufacture successfully used by Abraham Darby at Coalbrookdale in 1735. Dudley served as a colonel under Charles I. His work, "Metallium Martis," was published in 1665.

October 25, 1903. Robert Henry Thurston died.—A pioneer in engineering education in America, Thurston was trained as an engineer under his father and served in the navy during the Civil War. In 1870 he became professor of mechanical engineering in Steven's Institute, where he organised the first engineering laboratory in the United States; in 1880 he became the first president of the American Society of Mechanical Engineers. Removing in 1887 to Sibley College, Cornell University, he greatly extended the courses of instruction and by the time of his death the number of students had increased from 60 to 960. He was well known as a scientific investigator, and for his contributions to thermodynamics, steam engineering, and the strength of materials.

October 28, 1899. Ottmar Mergenthaler died.—The inventor of the linotype machine, Mergenthaler, who was born in Würtemberg on May 10, 1854, emigrated to America at the age of eighteen and worked as a watchmaker with his cousin in Washington. At Baltimore Mergenthaler came into contact with the reporter Clephane, and began work on a type printing machine which, after ten years and the expenditure of a million dollars, he at last brought to a successful issue. His linotype machine was first installed in 1886 in the composing room of the *New York Tribune*.

October 28, 1792. John Smeaton died.—The first "Civil Engineer" and the recognised father of his profession, Smeaton, like Watt, began life under an instrument maker in London. When in business for himself he gained a reputation by his scientific papers on wind power and other subjects. Though he constructed bridges and harbours he is known principally as the builder of the Eddystone lighthouse, an original work of great importance and utility which stood on the Eddystone rock from 1759 to 1882 and now forms a monument to Smeaton on the Hoe at Plymouth. Smeaton was a fellow of the Royal Society and in 1771 founded the Smeatonian Club for engineers.

E. C. S.

Societies and Academies.

LONDON.

British Mycological Society (Keswick meeting), September 15-20.—F. T. **Brooks**: Some present-day aspects of mycology (presidential address). It is maintained that the fungi originated from protist organisms without direct relationship with the algæ, and developed upon novel lines as an entirely separate and characteristic group of plants. Arguments are advanced against the view that the fungi are phylogenetically related to the green and red algæ, or that they have been evolved from transmigrant seaweeds in ancient times. A monophyletic origin of the fungi is favoured. Most plant diseases are caused by fungi; hence there is need for closer co-operation between systematic mycologists and plant pathologists. Attention was directed to the inadequacy of the diagnosis of certain genera and species of pathogenic importance, and to the great influence of environmental conditions upon the growth of all kinds of fungal organisms. It is considered that mycologists and plant pathologists must be essentially botanists with the necessary fundamental training in chemistry and physics. For the plant pathologist a sense of crop values and of the important phases in the growth of crops should be inculcated.—Somerville **Hastings**: *Anellaria separata* growing in the Alps. The characters of these plants are related to the known conditions and compared with corresponding characters in phanerogams.—A. H. R. **Buller**: Luminosity in *Panus stypticus*. The mycelium and fruit body are both luminous, and by controlling the supply of oxygen the light can be turned on and off instantaneously. The light is given off even at or just below the freezing-point of water. Mycelium grown on wood blocks remained luminous for six months.—Miss E. M. **Wakefield**: Fungus-hunting in the West Indies. Observations were taken during six months spent in the Lesser Antilles and Trinidad. The characteristics of the fungus flora of these islands illustrate the distribution of fungi as affected by climate and the differences between tropical and temperate fungus floras in general.—Carleton **Rea**: Edible fungi; qualities from a gastronomic point of view of a number of the larger fungi.—M. C. **Potter**: Wart disease of potatoes. Preliminary experiments appear to indicate that the disease does not develop if the soil is rendered sufficiently alkaline (approximately PH 10·5).

MANCHESTER.

Literary and Philosophical Society, October 3.—Mr. T. A. Coward, president, in the chair.—T. A. **Coward**: Manchester birds, 1822-1922 (presidential address). One hundred years ago, 1822, John Blackwall, famous for his monograph on "British Spiders," read before this society a paper on "periodical" birds observed in the neighbourhood of Manchester. This list was enlarged by him in his "Researches in Zoology," and the dates of observation extended from 1814 to 1828 inclusive. Blackwall also published a list of singing-birds, and of rare visitors, and contributed to various journals notes on the habits of birds. His works prove that the local avifauna has changed but little in spite of the great increase of population and the extension of the city boundaries. A few species have vanished, others have appeared and colonised, and though few birds can now be seen in Ardwick "fields" the same species which used to occur may be met with in the parks or on the outskirts of the populated areas. The possession of open spaces, and the protection afforded by the city authorities to birds in the parks, have saved many birds from local extinction.

MELBOURNE.

Royal Society of Victoria, July 13.—Mr. Wisewould in the chair.—H. B. **Williamson**: Revision of the genus Pultenæa. Pt. III. Six new species are described: *P. Boormanii* from N.S.W., *P. Kenneyi* (Q.), *P. teretifolia* (S.A.), and three from Victoria—*P. D'Altonii*, *P. prolifera*, and *P. Readeriana*. A number of new varieties are discussed.—W. M. **Bale**: Two new species of Bryozoa. *Catenicella Matthewsi*: nearly allied to *C. alata* and *C. carinata*, differs from all known species in having the alæ throughout uncalcified, perfectly hyaline, and apparently structureless. Alæ wide, fenestræ about 12-14, small, with converging fissures. Avicularia minute, on long arm-like processes. According to Levinsen's system a Pterocella. *Claviporella Goldsteini*: very close to *C. aurita*, but without the large elliptic suboral pore. Fenestræ 3, minute but distinct, with well-marked fissures. This character distinguishes it from *C. imperforata* and *C. aurita*. (The same as *Catenicella McCoyi* Goldstein, *nomen nudum*, Jelly's "Synonymic Catalogue").—E. F. J. **Love**: Gravity determinations in Australia. By comparison of all existing material, very precise determinations of gravity for Melbourne and Sydney observatories have been obtained. Helmert's new theory of the figure of the earth—according to which the equator is slightly elliptical instead of truly circular—reconciles in great measure the observed and theoretical values of gravity at the Australian stations; there is a possible correlation between gravity at a station and the geological age of the neighbouring strata.

WASHINGTON.

National Academy of Sciences (Proc., vol. 8, No. 9, September 1922).—P. **Franklin**: The meaning of rotation in the special theory of relativity. Newtonian equations for rotation can be used to express first approximations for points near the axis of rotation. Making certain assumptions, it is shown that the spacial geometry for the rotating system depends on the time and space co-ordinates of the point considered, and that the curvature of the spatial cross-section at any space-time point in its "natural" co-ordinates is the square of the angular velocity in radians per light-second.—J. A. **Eldridge**: Energy losses accompanying ionisation and resonance in mercury vapour. Electrons emitted from an oxide-coated cathode traverse a region of constant potential in the experimental tube, suffering collisions with mercury vapour; they pass through two diaphragms, each pierced by a single hole, to the receiving electrode in the lower end of the tube, which is freed from mercury vapour by liquid air. A retarding potential is applied to the receiving electrode. The current is plotted against the retarding potential and it is shown that, at voltages above the ionisation point, the most important type of resonance collision involves an energy loss of 6·7 volts and also that a collision involving an energy loss of 5·7 volts occurs in mercury. In an ionising collision, the impinging electron apparently loses all its energy, and the electron produced leaves the parent atom with negligible energy.—L. W. **McKeehan**: Crystal structure of beryllium and beryllium oxide. Beryllium in the form of a loosely packed powder in a pyrex glass tube was submitted to X-rays from a molybdenum target. The oxide was treated similarly to detect lines due to oxide present as impurity. The fundamental space lattice for both element and oxide was found to be hexagonal.—J. P. **Minton**: Some cases of nerve-deafness and their bearing on resonance theories of audition. Curves are plotted

showing the relative receiver current in the testing apparatus necessary for the threshold of audition at various pitches. It is found that unless the nerve endings or the nerves are destroyed, hearing is normal if the tones are sufficiently intense. The internal ear mechanism lowers the threshold of audition but mechanical resonance of this structure is not responsible for tone perception.—C. Lundsgaard and D. D. Van Slyke: The quantitative influences of certain factors involved in the production of cyanosis. Cyanosis depends on the mean concentration of reduced hæmoglobin in the blood. It is shown mathematically that 40 per cent. of venous blood must be mixed with arterial blood to obtain the necessary concentration of reduced hæmoglobin. Cyanosis usually becomes perceptible when this concentration is 5 gms. per 100 c.c. of blood, but various influences may cause it to vary from 4-6 gms. per 100 c.c. of blood.

Official Publications Received.

Recueil de l'Institut Botanique Léo Errera. Tome 10, fascicule 2. Pp. 83-456. (Bruxelles: M. Lamertin.)

Canada. Department of Mines: Geological Survey. Summary Report, 1921, Part A. Pp. 121A. Summary Report, 1921, Part D. Pp 110D. (Ottawa.)

Canada. Department of Mines: Geological Survey. Memoir 131, No. 112 Geological Series: Kenogami, Round, and Larder Lake Areas, Timiskaming District, Ontario. By H. C. Cooke. Pp. iv+64. (Ottawa.)

Sixtieth Annual Report of the Government Cinchona Plantations and Factory in Bengal for the Year 1921–22. Pp. 4+xii. (Calcutta: Bengal Secretariat Book Depot.) 8 annas.

Memoirs of the Indian Meteorological Department. Vol. 23, Part 5: On Cleaning and Refilling various Types of Barometer, together with a Description of several usual Patterns. By Dr. E. P. Harrison. Pp. 145-156+5 plates. (Calcutta: Government Printing Office.) 1·8 rupees; 2s.

Memoirs of the Indian Museum. Vol. 5: Fauna of the Chilka Lake. No. 10: The Hydrography and Invertebrate Fauna of Rambha Bay. By R. B. Seymour Sewell and Dr. N. Annandale. Pp. 679-710 + plates 32-43. (Calcutta: Zoological Survey of India.) 5 rupees.

1822 G. J. Mendel 1922. Herdenkingsnummer van Genetica. Nederlandsch Tijdschrift voor Erfelijkheids- en Afstammingsleer. Pp. 193-384. ('s Gravenhage: M. Nijhoff.) 8 gld.

Papers from the Geological Department, Glasgow University. Vol. 5: Octavo papers from 1918 to 1921. (17 papers.) Vol. 6: Quarto papers from 1915 to 1922. (15 papers.) (Glasgow: Maclehose, Jackson and Co.)

Report of the Danish Biological Station to the Board of Agriculture. xxviii., 1922. By Dr. C. G. Joh. Petersen. Pp. iv+103+5 Tables. (Copenhagen: G. E. C. Gad.)

Museums of the Brooklyn Institute of Arts and Sciences. Report upon the Condition and Progress of the Museums for the Year ending December 31, 1921. By William Henry Fox. Pp. 56. (Brooklyn, N.Y.)

University of Bristol. Calendar, 1922–23. Pp. 374. (Bristol.)

Proceedings of the Aristotelian Society. New Series. Vol. 22: Containing the Papers read before the Society during the Forty-third Session, 1921–1922. Pp. ii+242. (London: Williams and Norgate.) 25s. net.

Year Book of the Michigan College of Mines, 1921–1922, Houghton, Michigan. Announcement of Courses, 1922–1923. Pp. 127. (Houghton, Mich.)

Public Works Department, Government of India. Triennial Review of Irrigation in India, 1918–1921. Pp. viii+222. (Calcutta: Government Printing Office.) 5 rupees.

Records of the Survey of India. Vol. 15 (Supplementary to General Report 1919–20). Annual Reports of Parties and Offices, 1919–20. Prepared under the direction of Col. C. H. D. Ryder. Pp. 134+10 maps. (Calcutta: Survey General of India.) 4 rupees; 8s.

Cornell University Agricultural Experiment Station. Memoir 54: Horse Raising in Colonial New England. By Deane Phillips. Pp. 883-942. Bulletin 408: Production of new Strains of Corn for New York. By C. H. Myers, H. H. Love, and F. P. Bussell. Pp. 205-268. Bulletin 409: An Economic Study of Dairying on 149 Farms in Broome County, New York. By E. G. Misner. Pp. 269-444. Bulletin 410: Studies on Insects affecting the Fruit of the Apple; with Particular Reference to the Characteristics of the Resulting Scars. By Harry Hazelton Knight. Pp. 445-498+42 plates. (Ithaca, N.Y.)

Diary of Societies.

MONDAY, OCTOBER 23.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section), at 7.—R. D. Gauld: Some Factors in the Design of Steam Locomotives.

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—W. R. Ackland: Some Considerations for Preventive Dentistry (Presidential Address).

TUESDAY, OCTOBER 24.

ROYAL SOCIETY OF MEDICINE (Medicine Section), at 5.30.—Dr. Newton Pitt: Presidential Address.—Major-Gen. Sir John Moore and others: Glanders and Anthrax.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—The Secretary: Report on the Additions made to the Society's Menagerie during the months of June, July, August, and September 1922.—Exhibition of Photographs of Zebras and Oryx from Kenya.—E. T. Newton: Exhibition of a Tanned Skin of a Frog.—R. H. Burne and Prof. J. P. Hill: The Fœtal Membranes of Chiromys. R. Kirkpatrick and Dr. J. Metzelaar: An Instance of Commensalism between a Hermit-Crab and a Polyzoon.

INSTITUTE OF MARINE ENGINEERS, INC., at 6.30.—Views Illustrating Industrial Works: Messrs. Bruce Peebles.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 8.—E. W. Mellor: Some Landmarks of Ancient Egypt.

WEDNESDAY, OCTOBER 25.

NEWCOMEN SOCIETY (at 17 Fleet Street), at 5.—E. A. Forward: Simon Goodrich and his Work as an Engineer. Part I. 1796–1810.

FELLOWSHIP OF MEDICINE (at 1 Wimpole Street), at 8.30.—Dr. E. Pritchard: The Feeding of Infants from Birth to the End of the Second Year.

THURSDAY, OCTOBER 26.

CHEMICAL SOCIETY (at Institution of Mechanical Engineers), at 8.—Sir W. H. Bragg and Prof. W. L. Bragg: The Significance of Crystal Structure.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—Sir John Thomson Walker: Relation of Calcified Abdominal Glands to Urinary Surgery (Presidential Address).

FRIDAY, OCTOBER 27.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Geophysical Discussion on the Maintenance of the Earth's Electric Charge. Chairman: Sir W. H. Bragg. Speakers: Dr. G. C. Simpson, C. T. R. Wilson, and Sir A. Schuster.

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section), at 5.—Dr. E. Pritchard: Rickets (Presidential Address).

PHYSICAL SOCIETY OF LONDON, at 5.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Adjourned Discussion on paper by Prof. A. Rateau: The Use of the Turbo-Compressor for attaining the greatest Speeds in Aviation.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—Question and General Discussion Evening.

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.—Dr. R. J. Ewart: Economics and Tuberculosis.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 8.—Dr. G. H. Rodman: Familiar Flowers in Monochrome.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—Dr. R. Knox: Cardiac Diagnosis: A Survey of the Development of Physical Methods (Presidential Address).

PUBLIC LECTURES.

SATURDAY, OCTOBER 21.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: The Nile in the Life and Religion of the Ancient Egyptians.

MONDAY, OCTOBER 23.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. Shattock: Specimens illustrating Carcinoma.

CITY OF LONDON Y.M.C.A. (186 Aldersgate Street), at 6.—Sir Walter Morley Fletcher: Man's Body and the Making of Athletic Records.

TUESDAY, OCTOBER 24.

SCHOOL OF ORIENTAL STUDIES, at 5.—Prof. Alice Werner: Some Bantu Tribes of the Tanganyika Territory. Succeeding Lectures on November 7, 21, December 5, 19.

GRESHAM COLLEGE, at 6.—Sir Robert Armstrong-Jones: Physic. Succeeding Lectures on October 25, 26, 27.

WEDNESDAY, OCTOBER 25.

KING'S COLLEGE, at 4.30.—Dr. C. Da Fano: The Histology of the Nervous System. Succeeding Lectures on November 1, 8, 15, 22, 29, December 6 and 13.

SCHOOL OF ORIENTAL STUDIES, at 5.—Mrs. Rhys Davids: How to find the Real Founder of Buddhism. II.

UNIVERSITY COLLEGE, at 5.30.—A. Lloyd-Jones: The Phonetic Structure of the Yoruba Language.—L. S. Jast: The Organisation of a Great Library.

THURSDAY, OCTOBER 26.

CITY Y.M.C.A. (186 Aldersgate Street), at 6.—Sir C. Hercules Read: The Ancient Briton as Artist and Craftsman.

FRIDAY, OCTOBER 27.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Results following Resection of the Bowel, illustrated by Experimental Work done by Mr. T. Gray on Cats.

UNIVERSITY COLLEGE (in Botany Department), at 5.—Prof. A. H. R. Buller: Studies in the Morphology and Physiology of Fungi. Succeeding Lecture on November 3.—At 5.15.—Prof. J. Adams: The New Individualism in Education.

BEDFORD COLLEGE FOR WOMEN, at 5.30.—J. M. M'Gregor: Social Life in Athens, as illustrated by Plato.

SATURDAY, OCTOBER 28.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—F. Balfour-Browne: The Life and Habits of Mason Wasps.

SATURDAY, OCTOBER 28, 1922.

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Acoustic Research.

THE work of men of science has laid the foundation for a great many improvements in the technique of building, and this is, perhaps, most directly evident in the domain of physics. The utilisation of energy in the forms of heat and electricity form striking examples, but little has been done in this country in connexion with the control of sound. This is somewhat curious since in the late Lord Rayleigh we possessed one of the greatest exponents of acoustics. With the present-day congestion of our towns, which seems to be an inevitable factor in the progress of civilisation, the reduction of noise becomes of constantly increasing importance, and the present financial loss due to this cause must be very great, though probably impossible to estimate. Need also exists for investigation on the most efficient means of propagating sound in order to secure its most effective transmission and reflection.

The production of an acoustically successful auditorium is frequently of paramount importance in connexion with architectural design. Many of our public buildings erected by eminent architects show considerable faults in this direction, and as we may assume that these faults are not due to professional apathy, it would seem that the laws regulating the production of a successful building for hearing and speaking have yet to be worked out.

Unfortunately, the variations in the factors which have to be considered are many, and no two designs are wholly identical. Some opinions on this subject have recently been stated in the public press in connexion with the hall of the London County Council building, and the views expressed suggest that men of science are agreed that there is work to be done, and also need for work already done to be reduced to a form capable of absorption by the designer and constructor. Sir William Pope considers that quite a small expenditure of time and money would suffice to provide knowledge enough to enable an architect to render every hall acoustically perfect, but this view is evidently not shared by Sir Joseph Larmor; and others will be found who regard the subject as less easy of solution than might appear from the consideration of simple cases only.

Nor is the acoustic efficiency of public halls by any means the conclusion of the whole matter. There are more numerous cases in which the direct absorption of sound is of as great importance as is transmission in auditoria. In the hospital ward, the private sick-room, and in the office, where quiet and ventilation are so often incompatible, the best means of destroying unwanted sounds calls for scientific investigation.

That architects are not entirely indifferent to this subject is shown by the fact that on the formation of the Department of Scientific and Industrial Research several years ago, the Royal Institute of British Architects formally directed attention to the need for acoustic experiments, associated with design and construction.

This need is recognised elsewhere, as is evidenced by the work done in America where, at Geneva, Illinois, in the laboratory of acoustics built for the late Prof. Sabine by Col. Fabyan, much valuable research has been carried out. Before his death in 1919 at the age of fifty, Prof. Sabine had collected a great deal of experimental data on sound in relation to materials, and his researches had sufficiently impressed themselves on American architects more than twenty years ago to result in consultations on acoustic design. The laboratory is now under the direction of Prof. Paul E. Sabine, some of whose recent researches are referred to elsewhere in this issue with a brief description of his laboratory. In this building, devoted solely to acoustic problems, the difficulties of adequate sound transmission and suppression are constantly being investigated. Work of this nature must eventually prove a valuable national asset by preventing wasted effort and expenditure, and the example of America is worth serious consideration in this country.

There are a great many problems in which the work of the man of science can materially assist the architect, not only in acoustics but also in the use of materials for construction generally, but if science is to have its due appreciation it must supply information of a practical and simple kind which will appeal to workers in a field already so wide that they have little time for the study of theory, however interesting.

The Body Temperature of Birds.

A Study of the Body Temperature of Birds. By Alexander Wetmore. Smithsonian Miscellaneous Collections, Vol. 72, Number 12. (Washington, D.C., U.S.A.: Smithsonian Institution.)

WITH regard to body temperature, animals are divided into two great groups, namely, warm-blooded and cold-blooded, the former including mammals and birds, the latter reptiles, amphibians, fishes, and all invertebrates. A more accurate distinction than the actual temperature, however, is based on the fact that the so-called warm-blooded animals have a constant temperature (homoiothermal) while the cold-blooded animals have a variable temperature which is practically the same as that of the environment in which they live (poikilothermal).

The essential difference between these two groups is, that homoiothermal animals—mammals and birds—possess a heat-regulating mechanism by means of which the heat production and heat loss are so balanced that the body temperature remains practically constant, while poikilothermal animals—all others, except mammals and birds—possess no such mechanism.

Although much time and research have been devoted by a host of investigators to the study of body temperature and heat production in mammals, comparatively little attention has been given to this field in avian physiology, and all interested in this much-neglected subject will be greatly indebted to the author of the above monograph for his important and valuable contribution.

The investigation covered a period extending from January 1912 to October 1919, and records were obtained from 1558 individuals of 327 species of birds distributed among 50 families. It was carried on within the limits of the United States of America, and all the year round, in temperate regions where the extreme cold of winter is not encountered. In addition to the 327 species examined by the author personally, the previously published records from 89 others are given in the form of a supplementary table, so that definite statements may be found in the work regarding the body temperature of 416 species of birds. A table giving the individual records in detail, not included because of the high cost of printing, is deposited in the files of the Smithsonian Institution of Washington, and may be consulted by those interested.

Specially constructed thermometers of the clinical type but with a wider range—95° F.+to 115° F.+—were used. When a bird was shot a temperature reading was taken from the large intestine reached through the anus or from the proventriculus through the mouth, only when the specimen could be secured immediately. If there was any delay in retrieving a correct reading could not be made, so that it was only possible to secure records from less than half the birds collected. In the short time that intervened between the shooting and introduction of the thermometer, it is assumed that no appreciable loss of heat from the body took place, and that the figure recorded indicates the temperature immediately before death.

With regard to the diurnal rhythm of body temperature found in all homoiothermal animals, including man, the author was able to corroborate the work of previous observers, and it is particularly interesting to note that in nocturnal birds, such as owls, the normal rhythm is reversed, the temperature being highest during the night (period of activity) and lowest during the day (period of rest).

Hilden and Stenback found that by imposing an

artificial night (period of darkness) and day (period of artificial illumination) on birds confined in a darkened room the temperature rhythm was altered. After the second day the diurnal birds adapted themselves to the changed conditions so that the maximum temperature occurred at night and the minimum during the day. When the experiment was ended and birds again led a normal life in relation to daylight, the diurnal rhythm quickly returned. A similar change of rhythm has been produced artificially in the monkey. This bears on the question as to the cause of the diurnal temperature rhythm in animals. Some believe that there exists in the body a fixed periodicity of which the temperature rhythm is an expression, and that this periodicity persists under all conditions, and is, to a large extent, independent of outside influences. Others are inclined to question the existence of this mysterious periodicity, and look upon the diurnal variation as being due entirely to the action on the body of the various outside influences which affect body temperature, notably, muscular activity and sleep. The fact that the rhythm may be altered by changing the daily routine appears to give support to the latter view.

Although a distinct diurnal body temperature rhythm is found in birds with a wider range in many cases than in mammals, there is little evidence of a seasonal variation. This is all the more interesting, since no class of non-hibernating homoiothermal animals show greater evidence of cyclical bodily changes than do birds. During moulting time, in the late summer and autumn, they shed their feathers and show other signs of depressed vitality, while in the spring, in preparation for the mating and breeding seasons, they put on fresh plumage and become extremely active. However, heat production, if not greatly increased in a short time, has no relation to body temperature.

As in the case of mammals, the temperature of the female was found to be slightly higher than that of the male of the same species and under the same conditions, in most cases, but in certain groups the opposite was found. For example, in the herons (Ardeidæ), in three species we have the following averages: Great blue heron (*Ardea herodias*), male, 104°·8 F., female, 103°·7 F. snowy heron (*Egretta candidissima*), male, 104°·8 F., female, 104°·0 F.; and the black-crowned night heron (*Nycticorax nævius*), male, 103°·5 F., female, 102°·6 F. Here there is a very pronounced difference in favour of the male, and the same is found in certain other shore birds.

Among other factors that influence the body temperature of birds it was observed that large masses of food, if cold, will frequently cause a sudden fall in temperature in a bird of small size, while bathing may produce a slight fall.

As in the case of mammals, nestlings and immature birds show a lower temperature and a wider variation than adults, due to the fact that the temperature control is less perfect. In a black-necked stilt (*Himantopus mexicanus*), one day old, a temperature as low as 95°·3 F. was recorded. Apparently this applies only to species with altricial offspring; it is not found in birds with precocial young, where the mechanism of temperature control is well organised at birth.

In considering the method of temperature control in birds, Mr. Wetmore believes, with Soum, that the air-spaces play an important rôle in the regulation of heat loss. On account of the feather covering and the absence of cutaneous glands, little heat is lost by radiation and evaporation from the skin. This throws an increased burden on the respiratory system, supplemented by the ostial spaces, and the regulation of heat loss through this channel is the chief factor in avian temperature control. The author brings forward some first-hand evidence in favour of this belief.

Discussing the significance of temperature control in general, the statement is made that "In the bird, the regulation of body temperature has reached its highest point, though birds stand second to mammals from an evolutionary point of view. Proof of this is found in the fact that birds have the highest body temperatures known, and that none of them hibernate." This conclusion scarcely seems justifiable on the evidence at hand. The degree of heat control of any species is not to be measured by the actual height of the body temperature, but rather by its diurnal variation, and according to this standard the regulation of body temperature appears to have reached its highest point in *Homo sapiens*, since the diurnal range in him is less than in any other so-called homoiothermal animal so far investigated, although the actual body temperature is among the lowest for mammals and far below that of any of the birds.

It is generally held that the higher the bird in the zoological scale, the greater is the body temperature. The author agrees with this statement, as a rule, but points out many discrepancies. If the appended tables be examined it will be noticed that, when arranged by families, the highest temperatures are found in pigeons, cuckoos, woodpeckers, and in the great passerine order beginning with the Tyrannidæ and ending with the Turdidæ. In five species of the former the average body temperature for male or female was 110° F. or more. The highest average temperature for both sexes was found in the western pewee (*Myiochanes richardsoni*) with a mean of 110°·2 F., the greatest single individual reading being 112°·7 F. Contrary to popular belief,

it was found that the swallows, as a group, possess the lowest average body temperature. In seven species examined in this family one alone, the rough-winged swallow (*Stelgidopteryx serripennis*), showed an average greater than 107°·5 F. Humming birds also, "with their tiny bodies seem to have a considerable range in temperature, but as a whole fall low in body warmth."

The volume is an important monograph, containing much valuable data, and it is a noteworthy contribution to this field of avian physiology.

SUTHERLAND SIMPSON.

Prof. Eddington's Romanes Lecture.

Pour comprendre Einstein. Par l'Abbé Th. Moreux. Pp. 245. (Paris: G. Doin, 1922.) 7 francs.

Die Grundlagen der einstein'schen Relativitätstheorie: Eine kritische Untersuchung. Von Prof. Dr. H. Strasser. Pp. 110. (Bern: Paul Haupt, 1922.) n.p.

Philosophy and the New Physics: An Essay on the Relativity Theory and the Theory of Quanta. By Prof. Louis Rougier. Authorised translation from the author's corrected text of "La Matérialisation de l'énergie," by Prof. Morton Masius. Pp. xv+159. (London: G. Routledge and Sons, Ltd., n.d.) 6*s*, net.

Le Principe de la relativité et les théories d'Einstein. Par Prof. L.-G. du Pasquier. Pp. xvi+511. (Paris: G. Doin, 1922.) 18 francs net.

Le Principe de la relativité et la théorie d'Einstein. Par Dr. Leon Bloch. (Bibliothèque des Annales des Postes, Télégraphes et Téléphones.) Pp. iii+42. (Paris: Gauthier-Villars et Cie, 1922.) 3.50 francs.

The Romanes Lecture, 1922. The Theory of Relativity and its Influence on Scientific Thought. Delivered in the Sheldonian Theatre, May 24, 1922. By Prof. A. S. Eddington. Pp. 32. (Oxford: Clarendon Press, 1922.) 2*s*. net.

ANOTHER collection of books and pamphlets reminds us of the hold which the theory of relativity has on the public imagination.

The Abbé Moreux gives his book the title "Pour comprendre Einstein," though he seems to consider that the effort to understand him is so much waste of time, for in his view the theory is both superfluous and misleading. Dr. Strasser, an anatomist with an amateur's interest in physics, gives us a critical discussion of the theory, but it is manifest that he has not come near to understanding it. Prof. Rougier, a philosopher who has read all about the new physics, sets out to tell us something of the influence of the theory upon philosophy, but leaves us with the impression of a shallow and ill-digested understanding of the development of physical science and tells us little about philosophy. Prof. du Pasquier and Dr. L. Bloch are less ambitious in their aims; they are content to be expositors and not critics. The results are correspondingly more successful and will probably be very useful to the French reader.

But among the books before us, the English reader naturally turns to Prof. Eddington's Romanes Lecture to hear the latest thoughts of one who has done more than any man living to establish and to popularise the general theory of relativity.

The lecturer impresses it upon his audience that it is stale news that the events around us form a world of four dimensions. There is, however, something that is new. It used to be customary for us to think of this four-dimensional world as having a definite set of sections, any one of which represented the state of the universe at a particular moment of absolute time, the whole being thus stratified in recognisable layers. But now this stratification has disappeared, there are no absolute time sections; it is only the individual observer who, to meet his own convenience, dissects the whole into "rashers," labelling each with the mark of an instant of his own consciousness. With a wealth of illustration and with language both grave and gay Prof. Eddington seeks to cure us of our egoistic outlook, and to persuade us to the wider view which finds truth, not in a particular picture of reality seen from one angle, but in a vision which includes and comprehends every possible picture. "It is only in this undissected combination of four dimensions that the experiences of all observers meet." On this we need scarcely dwell here, save to remind ourselves that the fault from which he would save us is one to which men in all ages have been prone, and not the least sinners have been those whose profession was the pursuit of exact truth. Yet we cannot help feeling that at times the preacher goes too far and so damages his case. To quote an illustration from the lecture. We allow an apple to fall. The moment the apple is released the earth begins to rush up to meet it. This is "the apple's view of things." "It is simpler than Newton's. We should regard it as on an equal footing with that of a terrestrial observer." This is very like asking an engine-driver to admit that it is quite natural to consider that when he admits the steam to the cylinder he sets not the engine but the whole universe in motion.

This is trifling however. Let us return to our destratified world of four dimensions. If we have been able to achieve this vision or to conceive of its possibility, we have grasped the essence of the doctrine of relativity, and we have come near to a superhuman view of history. The world is laid out before us as a changeless whole. Time and space are no more.

All is static. Dynamics has been resolved away. We can no longer ask about causes; that is to go back to the human point of view. We can simply gaze upon the scene and seek to catch some of its salient features.

So far as our present conceptions go, one of the most striking things about the picture will be that it is fibrous. The tangible part of it will be a great number of threads, one-dimensionalities. These represent electrons. Mere mortals think of them as moving points, but with our new vision we see them as continuous threads. These are chiefly present in bundles, twisted together into ropes; what are these? They are the material bodies of the mortals. One is an atom. Another, much more complex, is a man; another is a chair. The former in one part is gathering more threads to itself; in another part the threads unravel and dissipate. Such is life. In one part the chair-rope and the man-rope are in contact; the man is sitting on the chair. But of the behaviour of man as mortal the picture tells us little. We must become mortal and see only sections of the picture before we can see him as a living being with an unfolding consciousness. If the poet and the mystic do indeed aspire to free themselves from the fetters of time and space, as we read in the concluding passage of the lecture, we fear that they will find but little left either of poetry or of mystery in the world after which they yearn.

But, leaving the poet aside, and returning to the physicist, what is left for him in the great synthesis of all science into the one map of all events? What becomes of his vocation of measurement? As Prof. Eddington emphasises again and again, he too, with all his experiments, is in the picture. His rules, scales, clocks, photographic plates are all there; their whole history is depicted. All his experiments of measurement are represented by the passage through the picture of the threads that represent the marks on the scales, meeting and intersecting the threads that represent other particles of matter. The four-dimensional picture itself is not to be measured. It contains within itself the process of measurement in the ordinary three-dimensional world and all the results are recorded for us to read. We have no four-dimensional scale which we may move about and apply to different parts of the picture for the sake of comparison. We merely stand, look, and try to read what we see.

Perhaps Prof. Eddington does not see the picture quite in this way. Perhaps the "world" for him is a four-dimensional continuum in which our threads are merely lines of singularity. He seems to contemplate as "measurable" the intervals between pairs of points in this continuum which do not correspond to events in the history of any particle or electron in the material universe. But we wish to ask him how these intervals are in practice to be measured. He says, "When we have mastered the geometry of the world we shall have inevitably learnt the mechanics of it." That is so. A complete description of the world lines of all particles necessarily tells us all about the phenomena of motion.

But to master the geometry of the world means to describe its main features by means of a few simple propositions. In Prof. Eddington's view, the process consists in measuring all the intervals between all pairs of neighbouring events, and then in examining whether these intervals will fit together in an Euclidean fashion, or in a particular type of non-Euclidean scheme. If we discover that they will fit in a recognised and manageable mathematical scheme, we have mastered the geometry of the world.

But we ask again how are these intervals to be measured. Since all measurements are contained in the picture, and since for the description of the picture event by event no system of intervals is necessary, the whole of our experimental measurements have nothing at all to do with a scheme of intervals, and any geometrical system whatever may be used for the purpose of attaching intervals. What, then, is it which discriminates between Einstein's system and any other possible one? It is simply this, that if we adopt that system, the facts of the motions of particles or of the propagation of light can be expressed in a very simple form. The path of Mercury, for instance, is a geodesic. Possibly this fact may be further analysed and shown to follow from the configuration of the electron being spherical. But in any case we cannot measure the tube which would represent such an electron in the super-world of four dimensions.

Thus Einstein's law of gravitation, by itself, is not a statement about the world at all. It is only when it is taken in conjunction with some other hypotheses, such as that the path of a particle is a geodesic, that it predicts anything, and becomes capable of experimental test. The world itself cannot be said to be either Euclidean or non-Euclidean, for it does not furnish us with definite values for the intervals between all pairs of events in the continuum. We may say that the world-phenomena are more simply described on the basis of a non-Euclidean system than on a Euclidean system; but it is surely not allowable to go further and say that this is "because the world is not a Euclidean or flat world." Prof. Eddington would perhaps reply that for him the world is nothing more than the measurements that we make of it, and that these measurements do not fit in a Euclidean scheme. But this brings us round again to the same question, what is meant by measurements of the four-dimensional whole? We would ask our lecturer to give us a sequel

to this discourse in which, assuming the four-dimensional presentation, he would state explicitly, either in general terms or by precise illustration, how he would compare the intervals between any two pairs of events.

E. CUNNINGHAM.

The Marketing of Whole Milk.

The Marketing of Whole Milk. By Dr. H. E. Erdman. (The Citizen's Library: Marketing Series.) Pp. xvi+333. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1921.) 21s. net.

THE recent disputes concerning the price of milk have again shown how difficult the problem has become under modern conditions, more especially in the large towns. The farmer is no longer able to take his milk direct to the consumer except in the case of a village or small town, and there has arisen a class of dealers or distributors who occupy the place of the middleman. Some of these distributors are large companies with the command of much capital, and their powerful organisations have led to something very like monopoly. The producers, on the other hand, have also organised themselves, and a struggle between the two parties has recently ended. In the volume under notice, this question as it appears in the United States is very completely analysed, and Prof. Erdman, who is an economist, has dealt with it more fully and critically than has previously been attempted. After discussing the peculiar position occupied by milk as a foodstuff, and the regulations which the public health authorities of all civilised countries have imposed, the author takes marketing and distribution, instances what has been done in the past and states the present position. The part played by the middleman and dealer is made clear, and the rise of collective bargaining is illustrated by the action of the Orange County farmers in their successful fight with the New York dealers in 1883, which may be regarded as the beginning of what has now become the general practice in the large American cities. The strike—or better the boycott—has been the weapon of the producers, and experience has shown that it is two-edged, owing to the difficulty which the farmer has in disposing of his milk—a perishable commodity—except by making it into cheese or butter or, at worst, by feeding it to stock, all of which courses are seldom remunerative. It is made clear that the producers must also submit to regulations governing their combined action, otherwise the results are doomed to failure.

Other matters dealt with are the difficulty of arriving at the cost of milk, owing to the position of the farm, the ability of the farmer, the proximity to market, and so on, and it is laid down that the method of arriving at a basic price can only be a starting-point in negotiations.

This book, which makes a strong appeal to the general reader, will be of interest to all concerned in the milk trade, whether as producers, distributors, or consumers, and it should lead to what the author regards as the only solution of the difficulty—"a better understanding all round."

Our Bookshelf.

Proceedings of the London Mathematical Society. Second Series. Vol. 20. Pp. liv+502. (London: F. Hodgson, 1922.) n.p.

THE present volume of the London Mathematical Society's Proceedings is the fifty-fifth issued since the foundation of the society and the twentieth in the present (large octavo) series. Like the preceding volumes issued by the society, it consists mainly of papers which embody original investigations on various mathematical subjects. Many of the papers, of which there are nearly forty, will appeal only to a limited class of reader. In mathematics, even more than in other sciences, the results of new investigations are apt to appear abstruse to the lay mind. The solution of a cubic equation, the Newtonian theory of gravitation, even the elementary applications of the calculus, fundamental and well known as they are now, were not familiar to the world, or even to the general run of university students, for many years after their discovery. By providing facilities for the publication of these specialised researches the London Mathematical Society has earned the deep obligation of the English mathematical world. Practically all the society's income is expended in producing its Proceedings, and, in view of the increased cost of printing, a large membership is essential to provide adequate funds. Inasmuch as every man is a debtor to his profession, every English mathematician should help to further the work of the society by becoming a member.

In the volume under review the articles most likely to appeal to the general reader are the excellent obituary notices of the late Lord Rayleigh and Herr Adolf Hurwitz, written by Profs. Lamb and Young respectively. There is also printed a presidential address on "Some Problems in Wireless Telegraphy" by Prof. Macdonald. Of the more technical papers it would be invidious to single out any one for special mention. The society insists on a high standard of excellence in everything it prints, and the inclusion of a paper in the Proceedings is a sufficient guarantee of quality. We notice that there is an almost entire absence of pure geometry from the present volume. Can it be that research in this subject is no longer encouraged in England?

The method of indexing each individual volume of the Proceedings leaves nothing to be desired. A subject index to the first thirty volumes of the first series was issued many years ago. We suggest that the time is approaching when the Council should consider the desirability of publishing a further subject index to the later volumes.

W. E. H. B.

A Laboratory Manual for Comparative Vertebrate Anatomy. By Libbie H. Hyman. Pp. xv+380. (Chicago: University of Chicago Press, 1922.) 2.50 dollars net.

THIS work is the outcome of a particular course of practical lessons conducted by its author. The disability which such an origin fastens upon a book is well known to every teacher of zoology, and Mr. Hyman's book is no exception to the rule. It suffers from the conditions of its birth—not that these, though American, were insalubrious, but that they were so highly specialised as to limit greatly the adaptability of the offspring. Nevertheless the care that has obviously been taken by the author, and his ability in presentation, should make his book useful even in our small cis-Atlantic schools of zoology, where a somewhat more elastic course of instruction is possible than that provided at Chicago.

Mr. Hyman rebels against the tyranny of the type system, and uses the comparative method of study in his laboratory. His chapters describe in succession the systems of organs of the Vertebrata as exemplified by Elasmobranchs (Mustelus, Acanthias, Raja), Urodeles (Necturus), a Chelonian, the pigeon, the cat, and the rabbit. The instructions for dissection are clear and sufficient; and an attempt is made to bridge the gulf which commonly yawns between the principles of the lecture room and the observations of the laboratory, by supplying an accompaniment of morphological comment in the form of introductions and summaries to the chapters. This device and the general nature of the first four chapters disguise—but do not dispose of—the evils of the type system, which are perpetuated in spite of the author's dismemberment of his types and the wide dispersal of their remains throughout the book.

Only one notable omission has been detected: Mr. Hyman's classification of the Chordates—two pages in length—ignores the Dipnoan fishes, nor in the whole of his book do they once appear, though the thesis often plainly demands them.

A pronouncing glossary forms a valuable appendix, though we fear its phonetics will not be acceptable to English ears. H. G. N.

Studies in the Theory of Human Society. By Prof. F. H. Giddings. Pp. vii+308. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1922.) 14*s.* net.

PROF. GIDDINGS points out that in science this century has been a time of rectification rather than of great discoveries. This applies particularly to the fundamental conceptions of sociology. These "Studies," which are always suggestive, frequently provocative, and in more than one instance illuminating, are a contribution to the revision of the theory of human society necessitated by the increased clarity and precision in scientific vision which has come about in the last twenty years. Their somewhat discursive character makes it difficult to give a concise account of the author's achievement in this direction; but, in brief, it may be said to lie in the application of a psychological interpretation to the conclusions of writers such as Darwin, Spencer, Bagehot, and Kidd, to name the more important, thereby accounting for social origins and the stages in the evolution of society in terms of the struggle for existence. Prof. Giddings's theory of human society is that social phenomena are a product of stimulus reacted to by "pluralistic" behaviour, giving rise to consciousness of kind—the "herd instinct" of other writers—from which are derived discriminating association, the ethical code, co-operation and division of labour, and, in the long run, selection and perpetuation of the adequate—the "fit" of an older terminology.

The Chemical Examination of Water, Sewage, Foods, and other Substances. By J. E. Purvis and T. R. Hodgson. (Cambridge Public Health Series.) Second and enlarged edition. Pp. viii+346. (Cambridge: At the University Press, 1922.) 20*s.* net.

IN this edition the authors have expanded the chapters on water and milk, given more details on the analysis of foods and beverages, and added "an outline of elementary toxicological analysis." A very good feature is the inclusion of plenty of typical analyses. The book will be found very valuable to students preparing for the examination of the Institute of Chemistry, and can be recommended as a useful introductory treatise. Although the quoted results of water analyses are given with the acids and bases combined, there is no indication as to how the necessary calculations are to be made, and some of the sections are so condensed that it is doubtful if they are of value. A great drawback to the utility of the book is its high price.

Modern Chemical Lecture Diagrams, with Uses and Applications fully described. By Dr. G. Martin, assisted by J. M. Dickson and Maj. J. W. Christelow. Pp. 88. (London: Sampson Low, Marston and Co., Ltd., n.d.) 3*s.* 6*d.* net.

THE purpose of this book is not clear. The illustrations are found in most text-books with adequate descriptions—those supplied in the present work are often too brief to be of any service, as "Fig. 5 shows how these tubes were experimented with by Andrews and Tait." Many of the diagrams represent apparatus far from "modern." The only calorimeters illustrated are those of Favre and Silbermann; chromium is prepared by Fremy's method; sulphuric acid is concentrated in glass retorts, etc. In some cases the descriptions are faulty: Bunsen's eudiometer is ascribed to Cavendish; the Almaden process for the manufacture of mercury is called "*Distillation* of mercury," etc. As a work of three authors a more modern result might have been expected.

Forensic Medicine and Toxicology. By Dr. J. Dixon Mann. Sixth edition, revised throughout. By Dr. W. A. Brend. Pp. xi+573. (London: C. Griffin and Co., Ltd., 1922.) 30*s.*

THE sixth edition of Dixon Mann's "Forensic Medicine and Toxicology," which ranks among the foremost English text-books on the subject, is the second to be edited by Dr. William Brend. It has undergone a revision which brings it completely up-to-date; a larger page is used than in previous editions, and the number of pages is reduced. The section on insanity has been rewritten on the basis of modern psychiatrical views; and that on toxicology gives additional information on poisoning by salvarsan, tetrachlorethane, T.N.T., and the gases of warfare, and on the infections formerly ascribed to ptomaine poisoning.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Relativity and Physical Reality.

IN a review by Prof. H. Wildon Carr entitled "The New Way of Thinking Physical Reality," which appeared in NATURE of October 7, p. 471, the writer (speaking of a work by Prof. Léon Brunschvicg) says regarding physical reality: "According to Einstein, we cannot say, speaking absolutely, that there is any picture even for God."

It seems to follow from this that not even the Almighty himself could understand the theory of relativity. If this be so I cannot help thinking that the fault lies with the theory of relativity and not with the Almighty.

The writer then proceeds to say: "The picture is only known as a function of the frame. That is, the things measured are only known through the measurings, and the measurings are bound up with the things they serve to measure."

This seems to imply that measurement is the fundamental thing to be considered in space-time theory, and with this I am not in agreement.

In my book, "A Theory of Time and Space," published in 1914, I showed that the ideas of measurement could be built up from the ideas of *before* and *after*, which were regarded as absolute and not dependent on any particular individual.

In my smaller book, "The Absolute Relations of Time and Space," I gave an abbreviated account of this work and added an appendix showing how the various complicated geometries which are treated of in Einstein's generalised relativity could be obtained by means of a modified measure of interval.

However, most relativists have been too busily engaged in praising Einstein to spare the time to go into my work.

One result of this has been that, by taking the idea of measurement as the fundamental thing, a very large number, if not the majority, of relativists have fallen into the very serious error of asserting that the length of what they call a "world-line" is a minimum between any two points of it. In my "Theory of Time and Space" I showed (p. 360) that this is not correct.

Finding that a number of writers were making this mistake, I wrote a letter which appeared in NATURE (February 5, 1920, p. 599) in which I invited attention to this matter and pointed out that in what I called "inertia lines" the length, so far from being a minimum, was actually a maximum in the mathematical sense; while, in what I called "separation lines" the length was neither a maximum nor a minimum.

In this letter I gave actual numerical examples to illustrate these points. I invited attention to the matter again in my "Absolute Relations of Time and Space" (p. 71), published in 1920.

In spite of these efforts of mine, I again find this blunder cropping up in works published this year. Now it seems to me that it is a very important point since, in ordinary geometry, there is no such thing as a "longest" line joining two points.

The idea would, I think, be apt to cause bewilderment in the mind of a person meeting it for the first time, unless it were properly presented to him. The idea of a "straight line" which was neither a maximum nor a minimum would, I fancy, cause even greater bewilderment, and he would wish to know how such lines were to be defined.

In Einstein's generalised relativity, the element of interval is taken as a starting-point, although the idea of an interval in the minds of many writers is so obscure that they ascribe a minimum property to it which it does not possess.

Although I have tried so often to impress on relativists that the ordinary method of treating space-time theory is unsatisfactory, I propose to make one more attempt to show that the measurement of intervals is not the simple thing that is so often supposed.

Let us consider the simple time-space theory in which the length of an element ds of what I call a "separation line" is given by the formula:

$$ds^2 = dx^2 + dy^2 + dz^2 - dt^2.$$

Let O be the origin of co-ordinates and let P be any point on the axis of x, at a distance l from O, measured, say, in the positive direction.

Let $F(x)$ be any arbitrary differentiable function of x which is continuous and single valued, and which is equal to zero for $x = O$ and for $x = l$.

Now consider the space-time curve the equations of which are:

$$y = t = F(x),$$
$$z = 0.$$

It is evident that this curve passes through O and P.

But now we have

$$dy = dt,$$
$$dz = 0,$$

and so $$ds^2 = dx^2.$$

Thus we have $ds = dx$, and so the length measured along the space-time curve from O to P is equal to the length from O to P measured directly along the axis of x. That is, it is equal to l.

Thus a space-time curve the equations of which contain an arbitrary function can have the same length between two points as the direct length measured between those points.

ALFRED A. ROBB.

October 11, 1922.

The Miraculous Draught of Fishes—an Explanation.

WE have in the Gospel according to Saint John, in his twenty-first and last chapter, an account of the miraculous draught of fishes in the lake of Galilee for which modern research into the habits of the Galilean fishes offers a perfectly reasonable explanation. The account is as follows:

"Simon Peter saith unto them [certain of the disciples], I go a fishing. They say unto him, We also go with thee. They went forth, and entered into a ship immediately; and that night they caught nothing. But when the morning was now come, Jesus stood on the shore. . . . Then Jesus saith unto them, Children, have ye any meat? They answered him, No. And he said unto them, Cast the net on the right side of the ship, and ye shall find. They cast therefore, and now they were not able to draw it for the multitude of fishes."

Simon Peter then girded his fisherman's garment around him and leaped overboard. But the other disciples brought their boat to shore dragging the net full of fishes with them. Further on we read: "Simon Peter went up, and drew the net to land full of great fishes, an hundred and fifty and three: and for all there were so many, yet was not the net broken."

The explanation of this is to be found in a study of the habits of the fishes living in the lake of Tiberius or

Galilee. These fishes are perch-like in form and affinities, so much so that the average American angler, especially if a small boy, would call them perches. However, ichthyologists to-day place them in a family called Cichlidæ, though they were formerly called Chromidæ. By one name or another, accounts of them may be found in systematic works on fishes.

The first ichthyologist to study these fishes in their habitat was L. Lortet, who made trips to the Holy Land in 1875 and 1880, and in 1883 published an extensive memoir based on the results gained at first hand. Lortet says[1] (p. 106):

"The fishes of the lake of Tiberius, very good to eat, serve as a pasturage for the myriads of crested grebes (*Podiceps cristatus*) and of pelicans. Frequently the grebes snatch at the eyes of the chromids, and with one stroke of their long sharp beaks lift out as cleverly as would a skilful surgeon the two eyeballs and the intro-orbital partition. These unhappy fish, now blind, of which we have taken numerous examples, have thus the entire face perforated by a bloody canal which cicatrises rapidly. It is only the larger individuals who are thus operated on by the grebes, for, not being able to avail themselves of the entire fish, these voracious birds take the precaution to snatch only the morsel of their choice."

The explanation of this we find on his next page, where we are told that these chromid fishes habitually swim at or near the surface of the water.

Canon H. B. Tristram made collections of fishes in the sea of Galilee in 1864, thus antedating Lortet by eleven years, but his book, "The Survey of Western Palestine. The Fauna and Flora of Palestine," was not published until 1884 by the Palestine Exploration Fund.[2] On page 164 he refers to the Chromidæ as found in the lake of Galilee in "amazing multitudes" and continues:

"All these Chromidæ are frequently found with their eyes extracted, and their foreheads pierced by the Grebes, which prey on them, but they seem to thrive perfectly well in spite of this mutilation, and to flourish in a state of absolute blindness."

Of *Chromis tiberiadis*, the most abundant form, Canon Tristram[3] writes:

"I have seen them in shoals of over an acre in extent, so closely packed that it seemed impossible for them to move, and with their dorsal fins above the water, giving at a distance the appearance of a tremendous shower pattering on one spot of the surface of the glassy lake. They are taken both in boats and from the shore by nets run deftly round, and enclosing what one may call a solid mass at one swoop, and very often the net breaks."

Dr. E. W. G. Masterman,[4] in chapter 2, "The Inland Fisheries of Galilee," of his book, "Studies in Galilee" (Chicago, 1909), thus describes the ordinary activities of the fishermen of the lake of Tiberius: ". . . their movements being directed by a man stationed on a point of the shore high above the water, who from his vantage ground is able to detect the presence of a shoal of *musht* (Chromids)." The fishermen, proceeding to the point indicated by the look-out, quickly run a net around the school. However, he tells us that the bottom everywhere is obstructed with large stones, and that the fishermen have continually to dive to free the net. This is possibly if not probably the explanation of Peter's leaping ovebroard.

From the excerpts given, it is plain as to the purport of the proffered explanation, if in the East, where customs change but slowly, we may interpret the past in terms of the present. Fish which go in schools at the surface of the water; fishermen who have not yet struck a school; Jesus on high ground looks over the lake, sees a school and points it out to the fishermen; they cast their nets in the direction indicated and draw them in full to the breaking point.

E. W. GUDGER.

American Museum of Natural History,
New York City, Sept. 27.

[1] Lortet, L. "Poissons et reptiles du lac Tibériade, etc.," in his "Etudes Zoologiques sur la fauna du lac Tibériade, etc." Archives Museum Histoire Naturelle de Lyon, 1883, vol. 3.

[2] The Palestine Exploration Fund is interdenominational in its organisation and sources of income. It has H.M. King George V. for its patron, and is supported by voluntary subscriptions. Its purpose is the thorough study of the archæology, geology, geography, history, natural history, etc., of Palestine.

[3] Dr. H. B. Tristram, Canon of Durham Cathedral, because of ill-health (lung trouble) lived in Algeria during the winters of 1855–1857. He went to Palestine in 1860 and remained for some years studying the fauna and flora, the resulting data being incorporated in his 455-page quarto volume, the standard work on the natural history of the Holy Land. In 1879 he was nominated for but declined the Anglican Bishopric of Jerusalem. He was the author of seven books on Palestine.

[4] Dr. E. W. G. Masterman is, and has been for a number of years, honorary general secretary of the Palestine Exploration Fund in Palestine.

Arabic Chemistry.

i. MAY I be allowed to direct the attention of those interested in the history of chemistry to an important paper by Prof. Eilhard Wiedemann of Erlangen? It is entitled "Zur Alchemie bei den Arabern" and is published in Heft V. of the "Abhandlungen zur Geschichte der Naturwissenschaften und der Medizin," Erlangen, 1922. It contains a translation of the passage concerning alchemy in the "Kashfu'l-Zunūn" of Hajji Khalifa, with many biographical details of the chemists mentioned. Several of these details have been provided by Prof. Brockelmann, the author of the monumental "Geschichte der arabischen Litteratur," and are entirely new. There is also a list of the most important works (with a few extracts) of the famous Aidamir al-Jildakī († 1361).

It is perhaps ungenerous to offer any criticism of so useful a contribution to chemical history, but I feel that Prof. Wiedemann's explanation of *'ilm al-mīzān* (science of the balance) as *Beziehung und Abwägung des richtigen Masses* should not be allowed to go unchallenged. As I have pointed out in the current number of *Science Progress* (October 1922), the term "Science of the Balance" as applied to alchemy refers to the proper adjustment of the *qualities* of a substance, that is, its hotness and dryness, etc., and is not used in a quantitative sense, even by Al-Jildakī, and certainly not by Jābir ibn Ḥaiyān, who, I believe, originated it.

A work by Al-Jildakī which seems to have escaped the notice of Prof. Wiedemann is "Zahru'l-Kimām," a commentary on an alchemical poem ("Qaṣīdatu'l-Nūniyya") of Abu'l-Aṣba' 'Abdu'l-'Azīz ibn Tammām al-'Irāqī (wrongly named Abu Casba by Berthelot, "La Chimie au Moyen Âge," tome iii. p. 4). Ibn Tammām al-'Irāqī was a contemporary of Al-Jildakī, who thought very highly of him.

ii. Berthelot (*op. cit.* p. 5) says, "Plusieurs des auteurs alchimiques arabes ont été traduits en latin, aux XII^e et XIII^e siècles, et ces traductions existent en manuscrit dans les grandes bibliothèques d'Europe. Un certain nombre d'entre elles ont même été imprimées . . . dans les collections intitulées *Theatrum chemicum, Bibliotheca chemica* (*etc.*). . . . A côté d'œuvres authentiques, je veux dire réallement traduites ou imitées de l'arabe, telles que la *Turba*, les écrits attribués à Rosinus, Morienus, Avicenne, etc., il en existe d'autres, fabriquées de toutes pièces en Occident, comme les prétendues œuvres des faussaires latins qui ont pris le nom de Géber."

The first part of Berthelot's statement is undoubtedly correct, although Berthelot himself was not able to discover the Arabic texts of any of the works he mentions as of probable Arabic origin.

Perhaps, therefore, the following facts will be of interest.

(*a*) In a work entitled "Knowledge Acquired concerning the Production of Gold," an edition of the text of which, with a translation, I have in the press (Geuthner, Paris), the author, Abu'l-Qāsim Muḥammad ibn Aḥmad al-'Irāqī, quotes several passages which he attributes to Marianus (Morienus, *supra*), the teacher of Khālid ibn Yazīd. Many of these passages occur in the Latin "Liber de Compositione Alchemiae," ascribed to Morienus, which is to be found on pp. 509-519 of vol. i. of Mangeta's "Bibliotheca Chemica Curiosa" (1702).

(*b*) On p. 217 of vol. ii. of the latter treatise is a work entitled "Epistola Solis ad Lunam crescentem," which begins, "In tenuitate enim nimia dabo tibi de pulchritudine mea lumen." This work is strongly Arabic in atmosphere, and is apparently a translation of the "Risālatu'l-shams ila al-hilāl" (Letter of the Sun to the New Moon) written by Abu 'Abdullah Muḥammad ibn Umail at-Tamīmī, who lived in the second half of the third century after the Flight (*ca.* A.D. 900). There is a manuscript of this work, with a commentary by Al-Jildakī, in the British Museum (*Add.* 23,418, xvi.). The Latin line quoted above is an exact translation of the first line of the Arabic poem; I have not yet seen the MS., so that I cannot say whether the agreement between the "Epistola" and the "Risāla" holds throughout.

The second part of Berthelot's statement, namely, that in which he expresses his opinion that Geber's works are forgeries, opens a question too wide for discussion here. I would point out, however, that Berthelot examined less than a dozen of the Arabic works of Jābir ibn Ḥaiyān, and as the latter is said to have written more than 500 books Berthelot was perhaps a little premature. Jābir, in his "Book of Properties" (a manuscript of which is preserved in the British Museum), refers to another book of his called "The Summary," which may possibly be the "Summa" of Geber. There is, moreover, in Mangeta (vol. i. p. 562) a work entitled "Testamentum Gebri"; now a commentator of Jābir's "Book of Mercy" refers to the same author's "Kitāb waṣiyya mautihi," or "The Book of his Last Will and Testament."

Evidence of this and other sorts is gradually accumulating, and it would not surprise me to find that Geber and Abū Mūsā Jābir ibn Ḥaiyān were, as for so many centuries they were held to be, one and the same. E. J. HOLMYARD.

Clifton College, October 9.

On the Occurrence of the Archiannelids, Saccocirrus and Protodrilus, on the South and West Coasts of England.

IN NATURE (vol. 91, pp. 85 and 348) the present writer recorded in 1913 the occurrence—for the first time in England—of abundance of Protodrilus in many situations, and a few Saccocirrus in one situation near Plymouth, and it was shown that both these forms have the curious preference for situations near high-water mark where fresh water trickles through or over the foreshore at low water, but covered by sea water at high tide (*l.c.* 348). Since 1913 the writer has searched for and found Protodrilus in similar situations and in a large number of places between Salcombe and Falmouth, and this year was successful in taking the same animal at two places on the west coast of England, namely, on September 7, near high-water mark where the Wanson (so-called) river runs into the sea at the south end of Widemouth Bay near Bude. (See Ord. Survey Map, 1 in. to mile, river Torridge, Sheet 127, 1H, 47-53), and on September 22 in a similar situation on a beach—formerly well known for shells—at Woolacombe (see O.S. Map, 1 in. to mile, Barnstaple, Sheet 119, 4C, 16-02).

In 1917 and on various occasions since, the writer has also taken large numbers of Saccocirrus (*e.g.*, 80 from a hole in the gravel about 1 ft. by 1 ft. deep in half an hour) on a beach at Portwrinkle in Whitsand Bay (see Ord. Sur. Map, 1 in. to mile, Plymouth, Sheet 148, 5F, 83-15) in a position exactly similar to that described formerly (*l.c.* p. 348). This year a few individuals were also taken in the gravel on the above-mentioned shell-beach at Woolacombe. Protodrilus and Saccocirrus therefore probably occur in all suitable situations in the south-west of England, and may no doubt be recorded—after search in suitable places—from a much more extended area in the British Isles. The specimens of each genus from all localities belong respectively to one species, so far as can be gathered from external characters, namely *Protodrilus flavocapitatus*, and an apparently new and as yet undescribed species of Saccocirrus. It is hoped that the characteristic restless side-to-side movement of the head and anterior region of Saccocirrus may shortly be portrayed by cinematograph.

Living in about the same situation as Protodrilus and Saccocirrus is almost always found the planarian *Gunda ulvae*. This planarian is large and easily found under stones in pools, and therefore serves as a guide in the search for the archiannelids. The apparent positive geotropism of Gunda, which is probably true, is an interesting phenomenon and not well known; if a number of the planarians be taken on a flat stone, they can be made to change direction a large number of times by holding the stone vertically towards the light and turning it repeatedly through an angle of 180°.

The occurrence of the above-mentioned animals only in the peculiar habitat where the water undergoes violent fluctuations in salinity suggests the presence of an undetected special food supply.

J. H. ORTON.

Marine Biological Laboratory,
The Hoe, Plymouth,
October 10.

Origin of the Name of the Genus Masaris.

IN Ed. André, "Species des Hyménoptères d'Europe et d'Algérie," vol. ii. p. 829, it is stated that the derivation of the name "Masaris" is unknown. The first species described under this genus is *M. vespiformis* F., from Egypt; it also occurs in Algeria.

May I suggest that the origin of the name is the Arabic name for Egypt, "Masr" (also used colloquially for its capital, Cairo). As a common noun "masr" means "a fortified place," and its plural is "amsar"; the word is connected with the Hebrew word rendered "Mizraim" in Genesis. It has long seemed to me that this derivation is at least probable, and I should be glad to know if any other has been suggested. E. W. ADAIR.

Turf Club, Cairo, September 26.

FABRICIUS, 1793, "Ent. Syst." ii. p. 283, in founding the genus Masaris, did not indicate any derivation for the name, and L. Agassiz, 1845, "Nomencl. Zool. (Hymenoptera)," masks his inability to give a derivation by the suggestion that Masaris is a proper name. F. A. B.

American Research on Acoustics.

By ALAN E. MUNBY.

THE Wallace Sabine laboratory of acoustics, a photograph of which is here reproduced (Fig. 1) is situated at Geneva, Illinois. It is a three-story building of brick and concrete specially erected for its purpose and forms a unique design, consisting of two structures under one roof, an inner room or sound chamber completely insulated from an outer shell. Figs. 2 and 3 show a plan and section of the building, the main feature of which is the sound chamber 27 ft. by 19 ft. and 19 ft. 10 ins. high. Here the original intensity of the sound is measured. The walls of this chamber are of 18-inch brick coated with cement outside and with wood fibre plaster inside, and the room as shown in the section has a separate concrete foundation. From this room half-way up

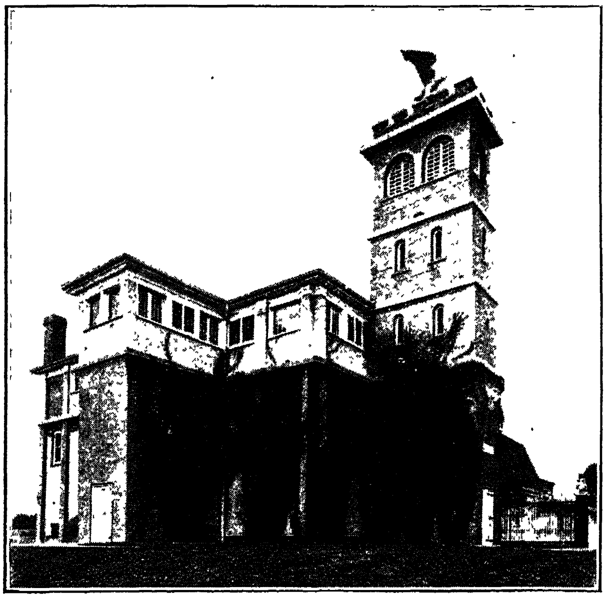

FIG. 1.—Riverbank laboratories, Geneva, Illinois.

its walls three small testing chambers are provided furnished with heavy steel doors to exclude sound completely. Materials to be tested are placed across these chambers, when the doors are opened to admit sound from an organ in the sound chamber. The organ is a complete 73 pipe instrument giving all the tones of the musical scale from C 64 to C 4096. It is operated electrically by the observer, who notes the time before a sound becomes inaudible in the test chamber. To ensure equality of sound distribution in the sound chamber a large steel reflector mounted on a central shaft is made to revolve in the room on a vertical axis. The main work, up to the late Prof. Sabine's death, has been connected with the calibration of the sound chamber and its instruments. This laborious undertaking completed, the activities of the laboratory should rapidly command a wider interest.

The present director of the laboratory, Prof. Paul E. Sabine, has recently published the results of an investigation on the nature and reduction of noises as occurring in business offices. Scarcely anything has been done in the way of investigation on the subject of noise, though the topic is obviously of wide interest. Prof. Sabine begins by pointing out that the sound-absorbing qualities of any material vary widely with pitch, and instead of attempting to apply data obtained for musical sounds, he wisely deals with the matter *de novo*, taking the actual sources of sound, such as the click of a typewriter, as the source for experimental purposes. A distinction is drawn between sounds in the open air and those in which reflection takes place, as in a room, from the point of view of the effect of the noise of one operator upon another. All but two or three per cent. of sound waves falling on a hard plaster wall are reflected, and in an experiment cited there were found to be 500 reflections before a given sound reached final decay. It would seem, therefore, that as much absorption as possible by walls and ceilings should be aimed at to prevent these reflections.

An important point brought out by these investigations is that the absorption efficiency of a given material for both musical sound and noise is greater when the material is employed in small units. In discussing practical measures Prof. Sabine alludes to linings of felt for walls, covered with some fabric, to light porous tiles and plaster, citing a plaster recently developed which is a much better absorber than ordinary plaster. He even makes a distinction between painted and unpainted walls, the general tendency of paints being to fill up a porous surface and thus decrease sound absorption, and numerical data are given showing the relative value of various surfaces in absorbing the sound of a typewriter. In these experiments the difference of power of absorption of a given material for various sounds, though existing, was found to be small.

Prof. Sabine has made a separate and special investigation of the absorption of sound by rigid walls and finds that the refraction effect on the passage of the sound into the new medium is of only trifling importance. His experiments have recently been further extended to tests upon artificial aids to hearing. He classifies the types of instruments commonly used and describes investigations to measure the difference of times during which residual sound may be heard with and without a particular instrument as a measure of the increase in loudness produced by that instrument. His results are illustrated graphically. It was observed that the highest tones in every case were less loud with instruments than without, suggesting that the short wave lengths enter the small cavity of the external ear better than do the air columns of instruments. With certain instruments also the lowest tone (frequency 128) was less well heard than without their aid. Prof. Sabine does not consider the prospects of improvements in alleviating extreme deafness to be good, but points the way by reference to the amplification of telephone currents by the thermionic tube, and he suggests a joint attack on the problem by physicists and physiologists.

Another series of experiments on sound-proof parti-

tions has recently been conducted by Mr. F. R. Watson, also of Illinois University, which are described in Bulletin No. 127 of the University. The results

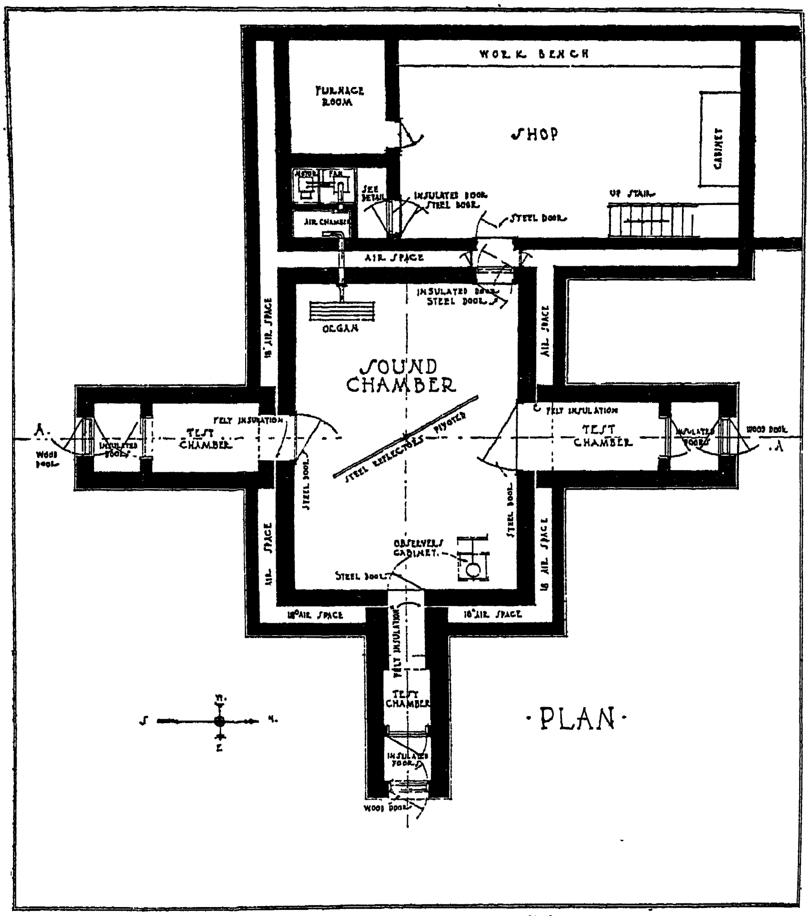

Fig. 2.—Plan of Acoustic Research Building.

have led to conclusions somewhat at variance with generally accepted ideas.

Sound, on striking an object, is reflected, absorbed, or transmitted, and usually all three results occur. In any particular case a definite amount of energy has to be got rid of in these ways, and for sound-proofing one may aim chiefly at reflection or absorption. When sound waves in one medium encounter another medium having a different density, the progression of the waves is disturbed, a certain amount of reflection takes place, some of the energy is absorbed, that is, converted into heat, while the amount transmitted through the medium will depend on its thickness and properties, such as porosity and rigidity.

In practice the materials used to separate rooms or buildings are usually of a complex character, and their rigidity will depend not only on their nature and thickness, but on the area of the separating wall. Hence the problem of assessing sound transmission is a very complex one. The author of the bulletin cited directs attention to the very detrimental effect as regards sound insulation of even small apertures caused by ill-fitting doors or by ventilators; he also makes a distinction between sounds due to air waves striking a separating medium and vibrations such as those caused by machinery, the former best resisted by heavy and rigid walling, the latter by arranging for absorption of the vibrations by beds of sand or like loose material.

From a useful résumé of previous experiments on sound transmission, the conclusion is drawn that rigidity is a deciding factor in sound prevention, and some experiments recently conducted by Prof. P. E. Sabine are cited which showed that a plate of glass three-sixteenths of an inch thick transmitted less sound than two glass plates with a sheet of celluloid sealed between them of the same total thickness. A series of tests made at the Music Building, Chicago, in 1895, is quoted, which tends to show that an air space between materials forming the two sides of a partition is of much less value for sound prevention than is commonly supposed, and that benefits which accrue from such space are almost wholly negatived by the inevitable connexion at intervals for structural reasons between the two sides.

In Mr. Watson's experiments use was made of the Rayleigh disc resonator, which admits of much more accurate and comparable results than are possible by aural comparisons adopted by many earlier experimenters. A very large number of materials were tested, and these were in all cases of satisfactory area—

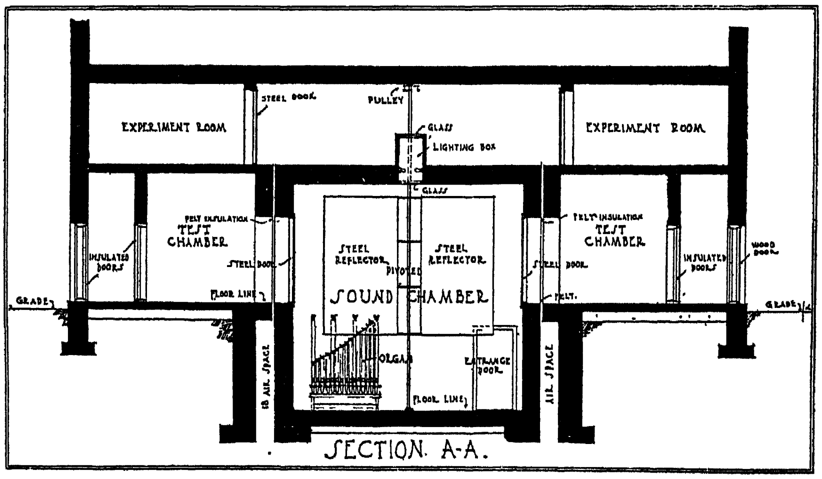

Fig. 3.—Section of Acoustic Research Building.

at least 3 ft. by 5 ft. An adjustable organ pipe blown at constant pressure formed the source of sound placed at the focus of a 5 ft. parabolic reflector facing the partition to be tested in the manner shown in

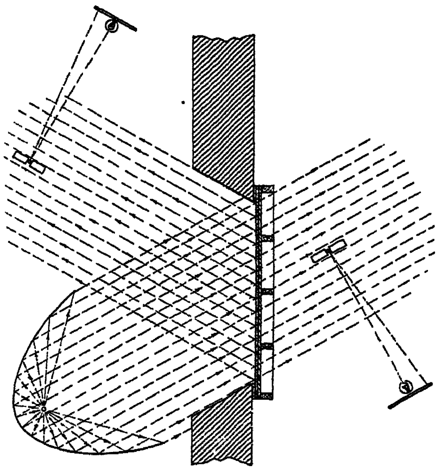

FIG. 4.—Diagram of apparatus for testing transmission and reflection of sound.

Fig. 4, and a disc resonator was placed on either side of the partition to measure the transmitted and reflected sound. Fig. 5 shows a photograph of the apparatus in use, and the observer's box provided to prevent disturbance due to his presence. The general results of the tests confirm the views of earlier experimenters cited. Porosity results in absorption but a good deal of transmission, while rigidity results in large reflection; the reflection from hair felt, for example, being 6, while that from Sackett board of the same thickness is 42·7.

The effect of openings such as doors were also tested, and it was found that if the transmission through a 2-inch metal lath and plaster partition has an intensity represented by 0·93, a 2-inch well-fitted solid wood door with three-sixteenths of an inch clearance from the floor increased this to 7·3 and with half an inch clearance to 11·7, showing the importance of even very small apertures. As regards composite partitions, the author's conclusions are that the small gain in internal reflection at surfaces of different density is usually more than counterbalanced by the loss in total rigidity, and thus in reflecting power of the initial surface of contact. In practice, of course, too much reflection may be detrimental to the uses of the room in which the sound is generated, and as is pointed out, absorption must be the ultimate aim for the destruction of sound, which means its conversion into heat.

Sound-proofing is of special interest in the modern type of business building, where, in order to economise space and admit of adaptability for changes of tenancy, the constructural brick wall has been so largely replaced by the thin partition, and experiments of the type described should be of great value to architects who are responsible for specifying materials and construction. The present writer's experience is that a wall composed of Fletton bricks, which are very dense, is less effective in stopping sound than one composed of stock bricks, which are more porous and less regular.

It would be unwise to generalise too much from the experiments described; with floors, for example, the direct contact produces conditions different from those of a sound wave in air, and through a solid concrete floor every footfall may well be heard in the room below. Much further work on this subject is needed, and it is to be hoped that investigation in this country will supplement and extend what is being done elsewhere.

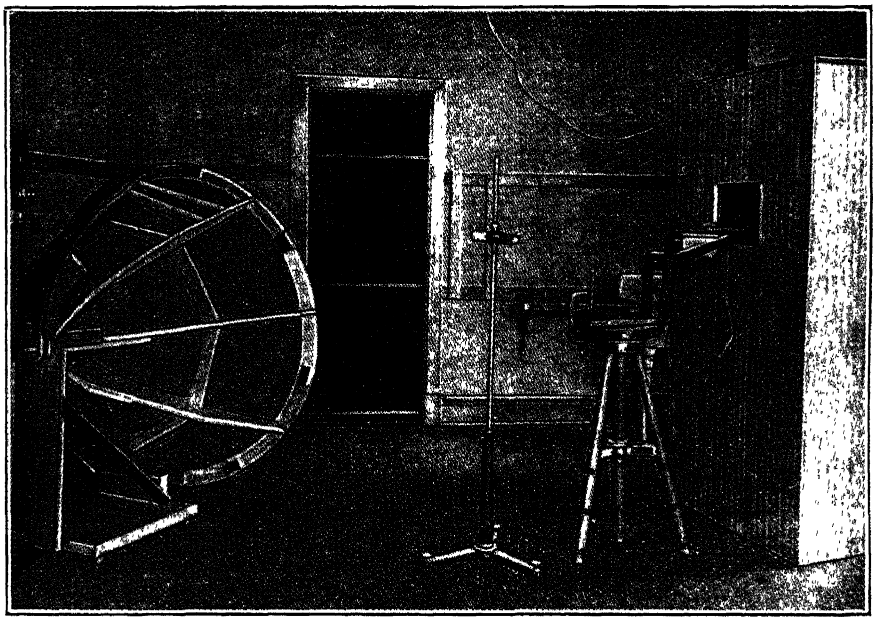

FIG. 5.—General view of apparatus.

The Galactic System.[1]

By Dr. HARLOW SHAPLEY.

II.

IN the first part of this article the main characteristics of the globular and open clusters were discussed, and it was shown how the determination of their distances led to the proposal of extremely great dimensions for the galactic system. A theory of the origin and structure of the Galaxy also seems to be indicated by the observations.

OBJECTIONS TO PROPOSED SCALE OF THE GALAXY.

Although the new values of galactic dimensions have been widely accepted by astronomers, at least qualitatively, they have been openly challenged by some. Without questioning my values (which may indeed have been unknown to him), Prof. Charlier published a few years ago provisional cluster distances that are of a wholly different order of magnitude from those I derive.[8] He had, in effect, affiliated the globular clusters with the local system of B stars. I believe he has now accepted the larger values of the distances.[9]

An extensive critical examination of my methods and results has been made by Prof. Curtis. His discussion and my reply have been published together in Bulletin No. 11 of the National Research Council.

Dr. Schouten has attempted to derive the distances of clusters by assuming that the frequency of absolute magnitude (the luminosity-curve) is the same in globular clusters and in the neighbourhood of the sun.[10] The method is questionable for several reasons: (1) All spectral types are lumped together by Schouten regardless of our present knowledge of the peculiar relation of type and luminosity in the globular clusters. (2) The giant-dwarf phenomenon is essentially ignored in the method. (3) The observed luminosity-curves in globular clusters do not conform with the law assumed.[11] (4) It is certainly improbable that the stage of evolution in any given cluster is closely comparable with the average of the many stages represented by the heterogeneous mixture around the sun. (5) As applied, the luminosity-curve method involves dangerous extrapolation, for we know the frequency of magnitudes for only the very brightest stars in clusters.[12]

Using the necessarily fragmentary luminosity-curves for a few clusters, Schouten finds distances averaging about one-eighth the values I have computed.

Recently, Kapteyn and van Rhijn published a valuable paper on the proper motions of Cepheid variable stars of the short-period sub-type.[13] It is generally accepted that Cepheid variables of long period are giant stars; and from the simultaneous occurrence of the long-period and short-period Cepheids in globular clusters,[14] I have assumed of course that the short-period Cepheids, which occur most frequently in clusters and serve in one of the methods of estimating the distances, are also giant stars. Kapteyn and van Rhijn, on the other hand, have computed, from the large values of the proper motion, small distances for the cluster-type variables, and therefore low luminosities. They conclude that Cepheid variables of this sub-type may be dwarfs, both near the sun and in clusters; and, by assuming that the long-period Cepheid variables in clusters are abnormalities and the short-period Cepheids are normal, they assert that the clusters may be at less than one-seventh the distances I place them. But Kapteyn and van Rhijn appear to have overlooked the decisive factor that the known radial velocities of these short-period Cepheids are remarkably high [15] (much too high, apparently, for the application of the method they use; [16] and therefore that the large proper motions they deduce and the wide distribution in galactic latitude are almost certainly the result of exceptionally high velocities in space, rather than an indication of nearness and low luminosity. Similarly, the long-period variables of spectral type M are giants at maximum, are widely distributed in galactic latitude, and have high space velocities.

As Dr. Crommelin has hinted recently in the *Observatory*,[17] a sufficient answer to those who would reduce the distance of clusters to one-fifth or one-tenth the values proposed, is that apparently they do not consider fully the dire consequences of such reduction on a vast body of other astronomical data that is now generally accepted. If the distances I give are not greatly reduced or increased these troubles do not arise; all that we know of the colours, spectra, magnitudes, and motions in the clusters, and of the clusters, then fits in well with our general stock of astronomical fact and theory.

Before we knew much about the character of stars in clusters we were not restricted by observation or theory from placing the clusters at whatever distances we liked. But now, if we alter the present distances by the amount Curtis, Schouten, and Kapteyn and van Rhijn suggest, we immediately set up peculiarities and discordances in great numbers. For example, among other difficulties evoked by such changes, we would seriously question the general applicability of the spectroscopic method of determining luminosities and distances; [18] we would introduce confusion into Russell's and Eddington's theories which now so happily conform with physical laws and observational results, in clusters as well as outside; we would overthrow the period-luminosity law of Cepheid variation. Sooner or later it may be necessary to divide or multiply by 1·5 (Dr. Crommelin suggests 2) the distances I have computed for the clusters; any larger factor will entail alterations elsewhere that now appear improbably large.

It seems to me that a better line of attack on the proposed scale of the Galaxy would be to question the apparent magnitudes rather than the absolute luminosities. The latter, as we have seen, are supported by too much evidence of a varied nature to yield easily. Moreover the values of the absolute luminosities for the stars in clusters come within the range of our usual experience, whereas the apparent magnitudes (and distances) of cluster stars are quite different from those of stars we ordinarily treat.

[1] Continued from p. 547.

Since the computed distances depend equally on absolute and apparent magnitudes, they could be considerably changed, if the apparent magnitudes are widely wrong, without disturbing present ideas about stellar luminosity. The fundamental work on magnitude standards at Mount Wilson, Harvard, Greenwich, and elsewhere supply, however, a basis of unquestioned value for the cluster work. The apparent magnitudes I have observed in clusters cannot, I believe, be far wrong;[19] but has the light of these distant stars been reduced in transit so that the apparent magnitudes as observed are not a true index of distance? This question should be kept in mind, but the following points seem to show that the observed apparent magnitudes do not differ seriously from true apparent values because of a hypothecated diminution of light during its passage through space:

(1) The absence of measurable differential light scattering in space, which would appear as a dependence of star-colour on distance.

(2) The apparent restriction of known obstructing matter to regions near the planes of the local cloud and the Galaxy;[20] the globular clusters we study are practically all outside these regions.

(3) The diameter-magnitude correlation for globular clusters, which shows, almost without exception, that the globular clusters with large angular diameters are bright, and that the faint globular clusters are of small angular diameter.[21]

(4) The absence of observable proper motion for clusters, notwithstanding large space velocities.

INCIDENTAL RESULTS

In the course of the investigation on the scale of the galactic system a number of incidental contributions of general scientific interest have been made.

I. The great distances of globular clusters provide a much more sensitive test of the degree of selective scattering of light in space than was formerly available from the studies of the colour of nearby stars. Results from many clusters, including the most remote, agree in showing no certainly measurable effect of distance on colour. We conclude that much less than one per cent. of the starlight is scattered while travelling for one thousand years through space.[22] This result, which does not hold of course for some restricted nebulous regions, indicates the extreme vacuity of interstellar space.

II. This absence of a measurable effect of distance on colour contributes an additional fact of some interest with regard to the nature of light. It is direct observational evidence that the amplitude of the light pulses of different wave lengths has suffered no differential alteration while travelling for more than 100,000 years. The age of this incoming stellar radiation, compared with that of the radiation used in laboratory experiments, is uncommonly impressive.

III. In a more definitely quantitative manner we can again use the base line in space and in time afforded by the globular clusters to derive another property of radiation. The times of maxima of several short-period Cepheid variable stars in the globular cluster Messier 5 (distance 12,000 parsecs) have been measured concurrently with blue and yellow light. Within the errors of observation no difference for the two colours is found in the time of these stellar outbursts.[23] That is, in travelling for 40,000 years, radiation that differs in wave length by 20 per cent. differs in time of arrival at the earth by less than two minutes, if at all. This is equivalent to a difference of less than one millimetre in a distance of 5000 miles. Stated otherwise, blue and yellow light travel with the same velocity with an uncertainty of less than one part in ten thousand million.

IV. In still another way can we make valuable use of the long base line provided by the remote clusters. A considerable analysis of the distribution of spectral types among the giant stars shows no measurable difference for near and distant globular clusters. This strongly suggests of course that the nearest systems are not appreciably more advanced in their evolution; but because of the finite velocity of light and the great differences in distance, they are, in our records, nearly 200,000 years older than the farthest ones. With these globular clusters we can, in effect, examine the process of stellar evolution throughout an interval of 2000 centuries. We find no evidence of change in that interval of time.[24]

Now Eddington has shown that very conspicuous advances in the evolution of a giant star would occur in less than 50,000 years, if gravitation is the main source of radiant energy.[25] We are led to believe, therefore, that gravitational contraction is not the main source of the energy that maintains the radiation of stars; it appears that the energy must come from the atom, and probably is released in the course of the transformation of the chemical elements.

The evidence for a slow stellar evolution is strongly supported, I believe, by the existence of stars, which are still in their giant stage, in the open clusters that move along the galactic plane. Dimensions now assigned the galactic system are so large that a single oscillation of a cluster must require millions of years. In fact, a greater space scale for the Galaxy practically makes necessary a long time scale and a slow stellar development. The extreme slowness with which the periods of Cepheid variables change, as Eddington has pointed out, also demands the new source of energy.[26]

V. In this connexion it may be observed that the question of the dependence of the speed of evolution on mass for a giant star is probably answered observationally by the regularly occurring phenomenon in clusters of increasing blueness with decreasing brightness. The well-known investigations by Eddington and Jeans indicate that high absolute brightness is associated with great mass, but the theory is not definite in regard to the relative rates of evolution for different masses. From the clusters we would conclude that the greater the mass the slower the development.[27]

VI. The most luminous stars in globular clusters, the spectra of which, by the way, appear to have the "*c*-characteristics" which are associated with extraordinary brightness, are more concentrated to the centre than fainter stars. This condition independently supports the inference that the most luminous are the most massive stars.

VII. The remotest object for which a definite estimate of distance has yet been made is one of these

faint globular clusters, N.G.C. 7006, for which a value of about 65,000 parsecs (more than 200,000 light-years) has been obtained, and checked by three or four different photometric methods. The most recent determination of its distance involved the discovery and study with the 100-inch reflector at Mount Wilson of Cepheid variables of the 19th apparent magnitude—the faintest periodic variable stars on record. It is likely that more remote objects, with distances as yet unmeasured, have been seen or photographed—possibly among the faintest spiral nebulæ or among the faint stars in the Milky Way.

VIII. A recent investigation of Cepheid variable stars in the Small Magellanic Cloud has shown that the very faintest variables have periods of less than one day.[28] This result, which permits the direct extension of the period-luminosity law to the short-period type of Cepheid, is further evidence of the high absolute luminosity of the kind of Cepheid variable which is most frequent in globular clusters.

IX. The proposal of a larger scale for the galactic system brings us face to face with the "island universe" theory of spiral nebulæ, which, with varying success, has for many years maintained that the spirals are other "universes" of stars—that they are galaxies comparable with our own, and that our Galaxy, seen from a sufficient distance, would appear as a spiral nebula. A theory of "comparable galaxies" immediately becomes very difficult to maintain along with the larger dimensions of the galactic system. In a paper published three years ago I discussed at some length this problem of external galaxies.[29] The conclusion reached at that time, that the nebulæ of the spiral family are probably neither galactic in size nor stellar in composition, has been strengthened rather than weakened by subsequent investigations, particularly by van Maanen's remarkable work on the motions in the brighter spirals.[30]

X. Since the brighter spiral nebulæ, according to the present view, are probably within the boundaries of our galactic system, it may be that the novæ occurring so frequently in the Andromeda nebula represent the encounter of this enormous, rapidly moving object with galactic stars. The suggestion is in harmony with the Seeliger-Monck hypothesis of the cause of ordinary nov; andæ, moreover, it is in line with the only hypothesis that has yet been advanced to account for the peculiar irregular variable stars in the diffuse nebulæ, such as those in Orion.[31] This interpretation of the variables of the relatively near Orion nebula would certainly be of significance for historical geology, since disturbances of our sun, much less serious in character than those observed for novæ and for the Orion variables, would be of paramount importance in matters pertaining to terrestrial climates and organisms.[32]

XI. Conversely we can use the geological records to show that the radiating equilibrium of the sun probably has been uncommonly stable compared with that of many stars. The investigation at Harvard under Prof. Bailey's direction of the frequency of galactic novæ brought out the remarkable result that at least fifteen novæ, brighter than the tenth magnitude at maximum, have appeared every year during the last three decades.[33] If a frequency of even one-fifth that amount has been maintained throughout the hundreds of millions of years of approximately constant solar radiation (shown by the geological records), more novæ have occurred than there are known stars. Our sun, however, which has certainly escaped not only disasters of this kind but even much less serious disturbances, apparently moves in an uneventful region of space.

XII. The attractive and somewhat futile speculations on the probability of the occurrence of protoplasmic life and its slow evolution elsewhere in the sidereal system must, of course, take account of the frequency of these calamitous stellar outbursts that we call novæ.

In connexion with this attempt at a partial interpretation of galactic structure it might be well to emphasise the following points.

(1) Many of the fundamental laws and assumptions of physics are involved in this sidereal superstructure, so that developments in thought or observation, which hereafter greatly affect these laws and customary assumptions, may at the same time seriously disturb existing conceptions of the sidereal system.

(2) The complete elucidation of the source of stellar energy may bring with it modifications both in our views of the evolution of stars and in our assumption of the importance of gravitational organisation of stellar bodies.

(3) The question of the obstruction of light in space is not in a satisfactory condition, and the nature of the radiation of the diffuse nebulæ is little understood; we have essentially no information concerning the pre-giant stage of stars and its relation to the diffuse nebulæ, and the dust and gases in space.

(4) Cepheid variables, though comparable with each other, may possibly be sufficiently different from other stars that we cannot use their speed of evolution as a quantitative measure of the speed of evolution for all stars.

For the present I take little heed of these warnings, and merely record them as examples of underlying uncertainties. They serve to remind us that the conclusions are based not only on favourable observations and theory, but also on the absence (for the time being) of seriously unfavourable data.

REFERENCES.

8. *Lund Meddelanden*, Series 2, No. 19.
9. Bul. Nat. Research Council, No. 11, p. 174.
10. Proc. Acad. Sci. Amsterdam, 20, p. 1108; 21, p. 36.
11. *Mt. W. Contr.* 155, and 175, p. 11.
12. I first tried out the method six years ago (*Mt. W. Contr.* 116, p. 81), but abandoned it as wholly unsuited to the brighter stars in globular clusters. The Kapteyn luminosity curves for separate spectral types, however, may be of high value.
13. Bul. Ast. Inst. Neth., No. 8.
14. Kapteyn and van Rhijn state that eight Cepheids of long period are known in two globular clusters. In my paper from which they get their data (*Mt. W. Contr.* 151) I show that twelve long-period Cepheids occur in the five globular clusters Messier 3, 5, 13, 15, and Omega Centauri. Four of these clusters contain also large numbers of short-period Cepheids only one or two magnitudes fainter than the long-period Cepheids. Unpublished results obtained at Harvard show that long-period Cepheids occur in other globular clusters.
15. *Mt. W. Contr.* 153, *Mt. W. An. Rep.* for 1918, and elsewhere.
16. Russell, *Astroph. Jour.* 54, p. 140.
17. *Observatory*, May 1922.
18. Bul. Nat. Research Council, No. 11, p. 184, 190.
19. The photovisual magnitudes for Messier 11, however, are probably affected by a serious scale error; the colour indices do not agree with the spectra subsequently determined (*Mt. W. Contr.* 120 and 228).
20. *Mt. W. Commun.* 62, p. 6; cf. also Hubble, *Mt. W. An. Rep.* for 1921, p. 251.
21. *Mt. W. Contr.* 115, p. 12, 152, p. 10, and 161, p. 13.
22. *Mt. W. Contr.* 156, p. 5.

23. *Harv. Bul.* 763.
24. *Mt. W. Contr.* 156, p. 5, and 157, p. 14.
25. *Zeits. fur Physik*, 7, p. 390.
26. Mon. Not. R.A.S. 79, p. 19.
27. This conclusion may not hold for close double stars, as certain results from eclipsing binaries are not in full agreement; the less dense, dark companion is believed to be, frequently, less massive and also less developed than its primary.
28. *Harv. Bul.* 765; Proc. Nat. Acad. Sci. 8, p. 69.
29. Pub. Ast. Soc. Pac., October 1919.
30. *Mt. W. Contr.* 213 and 214.
31. *Mt. W. Contr.* 156, p. 12; cf. Graff, *Ast. Nach.* 5133.
32. *Jour. of Geol.* 29, p. 502.
33. The annual number brighter than the tenth magnitude actually exceeds forty, according to Bailey's data. Pub. Am. Ast. Soc. 4, p. 248.

Current Topics and Events.

IN an article on Lord Inchcape's task in the *Sunday Times* of October 22, a former finance member of the Government of India, Lord Meston, makes an alarming suggestion. Speaking of things "useful, but not essential," he says "many of the research institutes and the like will come under the shears." The illiberal spirit which inspired our domestic wielders of the axe may thus be carried by one of them to India—a country which, more than any other, perhaps, has benefited by the application of science to "useful" purposes. The plant breeders there, alone, have literally added millions to the country's wealth; new wheats and cottons yielding 20 to 30 per cent more than the indigenous varieties have already been successfully introduced. It must not be forgotten that, in India, the prosperity of agriculture is a fundamental element of the solvency of the Government, for there, the State, as owner of the soil, takes one half of the rental value of the land. The sum thus raised approaches a moiety of the whole taxation of the country. It is to be hoped that such a suicidal policy as that indicated by Lord Meston will not be advocated by Lord Inchcape, though as a quondam member of the Geddes Committee he may be inclined to repeat its mistakes.

THE French airman, M. Maneyrolle, won the prize of 1000*l*. offered by the *Daily Mail*, by a wind flight on October 21 lasting three hours and twenty-two minutes. The notable successes registered during the recent French contests, and especially during the German contests, raised the question whether British fliers could rival the feats of their foreign colleagues, and the offer of a prize of 1000*l*. by the *Daily Mail* led to the organisation, at Itford Hill and Firle Beacon on the South Downs, of the first British gliding contests since the war, which commenced on October 16 and continued through the week. Additional prizes were offered by the Royal Aero Club and others. The entry of British machines and pilots was very encouraging, there being some two score British fliers, besides foreign aviators, notably the Dutch airman, M. Fokker. A large number of short flights and some quite long flights were made; yet on the whole the results of the meeting were not of a sensational nature until the last day of the meeting. The general conclusion is that British aviators do not fall behind those of Germany, and that it is possible to find suitable arenas in this country for the practice and display of motorless flight. The most notable achievement of the first day of the contest was a thirty-seven-minute glide by M. Fokker, but this was surpassed by a fine flight executed by Mr. F. P. Raynham. This aviator had already taken a place in the front rank of British pilots in the recent air-race round England: he added to his laurels by remaining in the air in a motorless machine for one hour and fifty-three minutes, thus putting himself in the same category as the German record-makers, Martens and Hentzen. But on the last day, Saturday, two world-records were nevertheless established. J. R. Olley went up in a Fokker biplane, and remained in the air with a passenger for forty-nine minutes, while M. Maneyrolle, in a tandem monoplane glider, succeeded in remaining in the air for three hours twenty-two minutes, thus winning the *Daily Mail* prize and beating the previous record, that of Hentzen, by twelve minutes. During the last ninety minutes of his flight, M. Maneyrolle was accompanied by a monoplane glider flown by Squadron-Leader A. Gray, and it was night when the two machines landed within 100 yards of the point from which they started. These competitions on the South Downs will serve as an encouragement to motorless flight in this country, and will help in the accumulation of knowledge and experience on one of the most interesting developments in modern aeronautics.

THE height of the ground at Firle Beacon, where the gliding competition referred to in the foregoing paragraph was held, is 718 feet above sea level, and it slopes downwards somewhat to Itford Hill, which is situated about three miles to the westward. The gliding was chiefly from one or other of these positions. The meteorological conditions during the week could not be considered altogether favourable, and there was wide difference in the weather on the several days. At times the winds were too boisterous and unsteady for gliding, while at others the gliding was hampered by winds which were too light or by cloud and mist; the direction of the wind was chiefly from between north and east. On the closing day, Saturday, the surface wind was blowing at the rate of about 20 to 30 miles an hour, and M. Maneyrolle, in his record flight, kept mostly at about 200 feet above ground. The controlling conditions of the weather were similar throughout the week; a region of high barometer was situated to the north of Scotland and a region of low barometer was fairly stationary over the north of Spain. All who took part in the gliding contest, however, would know well what different weather could be experienced with similar controlling conditions.

AT a meeting of manufacturers held on October 18 at the Institution of Electrical Engineers it was unanimously agreed, in view of the approval of the Postmaster-General to the memorandum and articles of association of the British Broadcasting Company having been obtained, to proceed with the registration of the company. The capital of the company,

amounting to 100,000*l*. in 1*l*. shares, has been guaranteed by the British Thomson-Houston Company, General Electric Company, Marconi's Wireless Telegraphy Company, Metropolitan-Vickers Electrical Company, Radio Communication Company, and the Western Electric Company: *bona-fide* British manufacturers alone will be allowed to join the broadcasting company and may take up one or more shares. The guaranteeing companies are immediately responsible for 60,000*l*. of the capital, and the balance of 40,000*l*. is offered for subscription: should applications be received for a number of shares in excess of the balance mentioned, the guaranteeing companies will reduce their holdings with the view of meeting the applications of other manufacturers. Lord Gainford has consented to become the chairman of the board of the broadcasting company, which, in the words of its memorandum, is a public utility service for the broadcasting of news, information, concerts, lectures, educational matter, speeches, weather reports, and theatrical entertainments. Each member of the broadcasting company is required to make a deposit of 50*l*., returnable to him when he withdraws therefrom; he must also enter into an undertaking neither to sell any apparatus, except batteries, accumulators, and aerial equipment, not made in this country, nor to make broadcasting apparatus for any person who is not a member of the company. For transmission purposes, every member owning an invention must give the use of the same to the company, *i.e.* all patents are to be pooled, so that the broadcasting company will be free of royalties. The expenses of broadcasting are to be met partly from the fees collected on broadcasting licences, the Postmaster-General having agreed to pay over one half of the 10*s*. to be charged for each licence to the company, and partly by contributions, on a royalty basis, to be made by the members of the broadcasting company; the scale of these contributions ranges from 2*l*. 5*s*. in respect of each three-valve set to 2*d*. in respect of each single valve sold. The date for opening broadcasting services has not yet been definitely fixed.

AT a joint meeting of the Royal Geographical Society and the Alpine Club on October 16, General the Hon. G. C. Bruce, Mr. G. L. Mallory, and Mr. G. I. Finch gave accounts of the recent expedition which failed by 1700 ft. to reach the summit of Mount Everest. Mr. Mallory said that in light of the experience gained this year the problem of climbing the mountain must be reviewed afresh. The most important modification must be in respect of porters. On this expedition porters had carried a camp to 25,500 ft. and had shown astonishingly little fatigue. It seemed certain that after a night's rest at 25,000 ft. the porters could carry a camp to 27,000 ft. If this could be done, it would facilitate the task, which would then depend on the endurance of the trained climbers. This would entail a climb of 2000 ft. and the corresponding descent in a day. The effort of climbing the last 2000 ft. should not be considerably greater than that of climbing from 25,000 ft. to 27,000 ft., for the difference in atmospheric pressure is only 0·8 in. between 27,000 ft. and the summit, compared with a difference of 19·5 in. between sea-level and 27,000 ft. But the fatigue of the previous days' efforts and possibly the ill-effects of sleeping at high altitudes would tell against the climber on the last lap. Mr. Mallory is not inclined to think that with the help of oxygen the feat was impossible. A significant fact was that three climbers at a height of 27,000 ft. felt no special distress. Two other considerations must be borne in mind: the dangers involved in avalanches and in the possible loss of muscular power, and the difficulties due to weather. The latter was most serious. Unless the bad weather of this year was abnormal, the weather factor reduces the likelihood of men reaching the summit of Mount Everest and descending in safety.

IT was stated in NATURE for September 16, p. 394, that a committee had been appointed to work out a proposed Federation of American Biological Societies. The constitution proposed by that committee is published in *Science* for September 29. It follows the main lines adumbrated in our previous note. We are glad to observe that, in the opinion of the committee, the Federation should in no way conflict with existing organisations, but should rather strengthen their efforts and should avoid unnecessary duplication of effort and expenditure. It proposes therefore to act in close co-operation with such existing agencies as the American Association for the Advancement of Science and the National Research Council. The kind of work that may be undertaken by such a Federation appears from the fact that the proposed constitution calls for the appointment of a Committee on Bibliography and Publication to act in co-operation with similar committees that may be appointed by the two bodies just mentioned. It may be remembered that the British Association has a committee dealing with the zoological branches of this subject, and that the recent Conference of Corresponding Societies requested the Council of the British Association to inquire into the general question of scientific bibliography.

MR. SPURLEY HEY, Director of Education in the city of Manchester, has been moved by our article on "Children and Museums" (NATURE, September 2, 1922) to send us a report on the lectures for elementary school children in the Museums and Art Galleries of Manchester. We were well aware of the admirable work begun in Manchester as a war measure, but found so successful that it has since been continued and extended. Classes are at present held in six institutions, and it is hoped to include three others. Of the eleven demonstrators engaged, nine are certificated teachers. Every attempt is made to co-ordinate the museum work with the inside work of the schools. There seems to be a larger demand for the science courses than for those at the art galleries, but all the courses are exceedingly popular with the children. The general opinion seems to be that these classes awaken the intellect of the children. It is natural that they should help them in such subjects as geography and science, but it appears that they also improve their drawing, teach them in

a practical way the elements of civics, cultivate their manners, and even give the children an increased pleasure in poetry. Indeed there is scarcely a side of education that is not improved in this way. We are not in the least surprised, and we commend Mr. Spurley Hey's report to all educationists as well as to those museum authorities at whom our previous remarks were aimed.

COMMANDER FRANK WILD, leader of the Shackleton-Rowett Expedition after the death of Sir Ernest Shackleton, and Mr. John Quiller Rowett, who financed the expedition, had the honour of being given an audience by the King on Monday morning. The King expressed his deep regret for the untimely death of Sir Ernest Shackleton, and complimented Commander Wild on the successful work accomplished.

WE much regret to announce the death on October 27, in his eighty-second year, of Mr. W. H. Wesley, for forty-seven years assistant secretary of the Royal Astronomical Society.

THE second annual meeting of the Deutsche Gesellschaft für Vererbungswissenschaft was held in Vienna on September 25-27. Though technically a meeting of the German society only, in fact the congress was largely international in character, the visitors including representatives from England, America, Italy, Switzerland, Japan, Holland, and the Scandinavian countries. Prof. R. Wettstein presided, and the opening address was delivered by Prof. E. Baur (Berlin). The principal discussions were opened by Prof. Goldschmidt (Berlin) on "The Mutation Problem," and by Prof. Ruedin (Munich) on "The Inheritance of Mental Defects." Among the papers which were read and briefly discussed were the following: the modification of sex factors in fungi, by H. Kniep; relative sexuality, by H. Hartmann; *experimenta crucis* on the inversion of sex, by R. Goldschmidt; experiments with hermaphrodite frogs, by E. Witschi; linkage in antirrhinum, by E. Baur; the deficiency phenomenon in Drosophila, by O. L. Mohr; methods of obtaining different sex-proportions in Drosophila, by G. Bonnier; polymery in butterflies, by H. Federley; parthenogenesis, gynandromorphism, and the determination of sex in phasmids, by H. Nachtsheim; Blakeslee's experiments on heredity in Datura, by C. B. Davenport; the influence of temperature on the offspring of rats, by H. Przibram; the influence of light on butterflies, by E. Brecher; genetic studies in barley, by E. Schiemann; vegetative segregation in *Lupinus angustifolius*, by H. Roemer; transplantation and relationship, by Frl. Erdmann; the inheritance of Hæmophilia and its importance for our conception of the nature of genes, by H. K. Bauer; and variability and the formation of species, by P. Schlesinger. Demonstrations were arranged in the zoological laboratory of the University and in the Natural History Museum. Visits were made to the Biologische Versuchsanstalt (where Prof. Steinach demonstrated his transplantation experiments in rats and guinea pigs) and to the principal libraries and art galleries in the town. Prof. R. Hertwig was elected president for the ensuing year, and the society accepted his invitation to meet at Munich in 1923.

AN international exhibition of technical, artistic, and scientific photography, optics and cinematography, with a section for the history of photography, will be held in May and June of next year at Turin, Italy. Information can be obtained from the Comitato dell' Esposizione Fotografica, presso la Cemare di Commerciodi, Torino, Italy.

THE council of the Hancock Museum has appointed Mr. T. Russell Goddard, at present assistant curator at the Sunderland Museum, to the position of curator of the Hancock Museum, Newcastle-upon-Tyne. Mr. Goddard was trained under Mr. Montague Browne, and then worked on the staff of the Leicester Museum under Mr. E. E. Lowe for six years, arranging and classifying the local fauna and flora. Thence he proceeded to engage in biological research work in the laboratory of Dr. C. F. U. Meek, previous to his appointment at Sunderland about two years ago.

WE have received the second quarterly issue for this year of *Process Work and the Printer*, which contains among other interesting items an article on "The History of Printing Types," reprinted from the *Printing Supplement* to the *Manchester Guardian*. It is illustrated with many specimens from Gutenberg's first type (1455) to those of the present day. One of the three inset illustrations is a photogravure in colour, but the original water-colour drawing is of such a character that it is not possible to judge of the quality of the reproduction. The editor states that it marks a notable departure in photogravure printing in that it necessitates the printing of a large edition instead of only a few proofs as has hitherto been the case in colour photogravure.

THE Cantor Lectures delivered recently before the Royal Society of Arts by Prof. Arthur M. Hind, Slade professor of fine art in the University of Oxford, on "Processes of Engraving and Etching," are printed in the Society's Journal for September 22. The lecturer does not treat the subject as a practical engraver, but from the point of view of the historian and critic. He seeks chiefly to discriminate the characteristics and limitations of the various processes, and their peculiar fitness for certain kinds of work. The subject is richly illustrated by reference to a very large number of examples. Prof. Hind concludes by stating that "perhaps the greatest danger to recent etching has been its popularity; the public has preferred a bad etching to a good woodcut or lithograph, leaving these other arts a safer though less prosperous field. It is perhaps on that account that some of the best etchers are those who have exhibited least."

DR. GEORG BERG has written to us with reference to a review of his work on ore deposits published in NATURE of August 12, p. 205, to point out that the reviewer has done him an injustice in stating that he restricts the term syngenetic deposits to magmatic segregations. In this correction Dr. Berg is undoubtedly right; he does include among syngenetic deposits such ore beds formed by sedi-

mentation as have undergone no chemical change since their deposition, as well as clastic deposits. Unfortunately, he has dealt with the former type of syngenetic deposits (magmatic segregations) first, has then passed to the study of epigenetic deposits, and then, after some 280 pages out of a total of 400 devoted to epigenetic deposits, he reverts to the last two classes of syngenetic deposits, and this method of dealing with the subject caused the reviewer to overlook the fact that Dr. Berg had commenced by stating that these two last classes (ore beds and clastic deposits) were also syngenetic. This explanation will, we trust, suffice to remove the wrong impression created by the comment to which Dr. Berg refers.

MESSRS. W. HEFFER AND SONS, Ltd., are bringing out "Fundamentals of Bio-Chemistry in Relation to Human Physiology," by T. R. Parsons, which is intended to form an introduction to the study of the chemical processes at work in the body. It is addressed more particularly to medical students reading for examinations in physiology. Another forthcoming book in the same publishers' list is "The Ethnology of the American Indians," by Dr. P. Radin, in which particular stress is laid upon a clear delineation of the civilisations of Mexico and Peru and their influence on the culture of the other parts of America. A useful feature of the volume should be the detailed and critical bibliography it is to contain.

Our Astronomical Column.

A NEW COMET.—A new comet, 1922 *c*, was discovered by Dr. Baade at Bergedorf Observatory, Hamburg, on October 19, and observed by Prof. Strömgren at Copenhagen on October 22, 8^h $15{\cdot}7^m$ G.M.T., in R.A. 19^h 52^m $57{\cdot}7^s$, N. Decl. 36° 57′ 38″. He gave the magnitude as 9·0, so the comet should be visible in small telescopes. Assuming uniform motion, the following are the positions for the dates named at 8^h P.M.:

	R. A.	N. Decl.
Oct. 28.	20^h 6^m 2^s	35° 22′
„ 31.	20 12 35	34 33
Nov. 3.	20 19 8	33 44

The comet is in Cygnus, and is due south, 15° from the zenith, at 5^h 30^m P.M.

SPECTROSCOPIC PARALLAXES FOR TYPE A.—The spectroscopic method has hitherto been limited to spectral types F G K M. A paper by Messrs. Adams and Joy (Proc. Nat. Acad. Sci., July 1922) gives the details of an investigation as to its extension to type A. It had already been noticed that there was a difference in the general sharpness of the spectral lines in stars of this type, and on examining the stars the distance of which is known either by trigonometrical, hypothetical, or moving-cluster parallaxes, there is found to be a distinct correlation between absolute magnitude and sharpness of lines. Using the letters s, n to denote sharp and nebulous spectra, they give the following values for the absolute magnitudes of different types: A1 s 0·0 n 1·2, A2 s 0·6 n 1·5, A3 s 1·2 n 1·7, A4 s 1·5 n 1·9, A5 s 1·8 n 2·1, A6 s 2·1 n 2·2. After this point the two coalesce. They apply the formulæ to the Taurus group and the Praesepe, finding parallaxes of 0″·024 and 0″·011 respectively. Certain stars had already been classified at Harvard as C-stars. They have very sharp and narrow lines, and the enhanced lines, especially those of strontium at 4077 and 4215, are very intense. There is reason to think that these stars, of which α Cygni is the most prominent example, are super-giants, to which the preceding formulæ do not apply. They are very luminous and very remote, but material for assigning parallaxes is at present wanting. The authors note that in all spectral types sharpness of lines is associated with high luminosity. They explain this by the very low density of the giant stars.

A paper by Mr. Evershed in the Mon. Not. R.A.S. for last May noted that there were many broad hazy lines in the spectrum of Sirius; he pointed out that in Sir Norman Lockyer's classification, Sirius is on the descending side of the temperature curve, and quotes his words that in stars of this class the hydrogen lines are relatively broad. Mr. Evershed is inclined to explain the widening as a Doppler effect due either to rapid rotation or strong convection currents. But, whatever the cause, the facts are in accord with the results of Adams and Joy.

GLOBULAR CLUSTERS IN THE LARGE MAGELLANIC CLOUD.—In Harv. Coll. Observ. Bulletin, No. 775, is announced the discovery that five objects formerly catalogued as nebulæ are definitely globular clusters. Their N.G.C. numbers are 1783, 1806, 1831, 1846, 1978. The status of two others, Nos. 1651, 1866, is doubtful. The detection of new globular clusters is interesting, since it was announced a few years ago that probably all objects of this class within our reach had been detected. It also enables a new estimate to be made of the distance of the cloud, using Prof. Shapley's formulæ. At present only the simple formula based on apparent diameter has been applied. The diameters of the above five objects are 1′·9, 1′·6, 1′·9, 1′·8, 1′·8. The corresponding distance is 35 kiloparsecs, or 110,000 light-years. This is of the same order as Hertzsprung's estimate. It makes the linear diameter of the large cloud 4½ kiloparsecs, so that it is comparable in size with our own star system, leaving the outlying galactic extensions out of account.

VARIABILITY IN THE LIGHT OF IRIS.—Prof. Wendell noted in 1904 that this minor planet was variable in light to the extent of 0·35 mags. in 0·259 days. Mr. Campbell found the same period but a smaller range in 1917. But Miss Harwood at the Maria Mitchell Observatory finds no variation in the present year. The case is like that of Eros, and may arise from irregular shape of the object, the amount of variation depending on the direction of the line of sight; it has been suggested that a further complication might arise from a shift in the axis of rotation in the body of the planet, if it were rotating about an axis other than a principal one. The shape of the asteroids might give a clue in questions of cosmogony, hence such researches are useful. In the case of Eros, when observed for parallax there is the possibility of error if the centres of light and of gravity are non-coincident. Mr. Hinks, indeed, found some evidence of a small oscillation of this kind, but the effect would probably disappear in the mean of many observations.

Research Items.

EARTHWORKS IN AMERICA.—The Peabody Museum of American Archæology and Ethnology, Harvard University (vol. viii. No. 3), has issued a monograph by Mr. C. C. Willoughby on the Turner group of earthworks in Hamilton County, Ohio, with notes on the skeletal remains by Mr. E. A. Hooton. The book, admirably illustrated by sketches and photographs, gives a full account of these interesting structures. Mr. Willoughby remarks that the builders attained a degree of excellence in art design probably unsurpassed north of Mexico. It is important to note that they show no affinity with the people of the Madisonville site, beyond those which are common to all Indians. Their affinities are rather with the Eastern dolichocephals, although there is present a brachycephalic element such as is often found among the Eastern Indians.

LONG BARROWS IN THE COTSWOLDS AND WELSH MARCHES.—Under the title of "Notes on the Archæological Information incorporated in the Ordnance Survey Maps," Mr. O. G. S. Crawford, Archæology Officer, Ordnance Survey, has published a useful pamphlet with a map showing the position of the Long Barrows and Stone Circles in the Cotswolds and the Welsh Marches. He remarks that the fact that the Cotswold limestone area is a region of relatively high elevation has led some to suppose that this accounts for the abundance of long barrows in this district. But the factors which influenced prehistoric man in the choice of a settlement were not elevation but vegetation and water supply. Prehistoric man selected these limestone areas when the soil favoured an open growth of vegetation, because many regions of high elevation, such as the Black Mountains, are entirely devoid of long barrows. He chose sites where the streams are more numerous, and in Monmouthshire the position of two out of the three long barrows shows that Neolithic man did not shun the lowlands when they served his purpose. Mr. Crawford's introductory essay is interesting and suggestive, and it may be hoped that archæologists will soon be in possession of similar maps indicating the position of prehistoric remains in other districts.

THE PAINTED GLASS OF GLOUCESTER CATHEDRAL.—In that gem of ecclesiastical architecture, the Lady Chapel of the Abbey, Gloucester, the east window, a work dating from the end of the 15th century, at once attracts attention. But the glass is in such a confused and disordered state that the ordinary spectator is scarce able to distinguish any definite subject, and carries away the impression of a mere mass of richly toned fragments, with here and there a face or a form dimly visible. The scheme of the window was obviously to illustrate miraculous stories about the Virgin, but hitherto little has been done to arrange the fragments in a definite way. In the Transactions of the Bristol and Gloucestershire Archæological Society for 1921 (vol. xliii.) Mr. G. M'N. Rushforth, working on a catalogue prepared in 1915 by Mr. J. D. Le Couteur, a well-known authority on medieval glass, publishes an exhaustive paper, supplied with good photographs. Many of the figures and incidents have now been satisfactorily identified, and much new light is thrown on an important collection of 15th century painted glass.

GERMINATION OF INDIAN BARLEY.—Experiments on the influence of atmospheric conditions on the germination of Indian barley have been carried out by Mr. W. Youngman, Government economic botanist, United Provinces, and the results, which have been published as a memoir of the Indian Department of Agriculture, are summarised in the *Bulletin of the Imperial Institute* (vol. 20, No. 2). It was found that if barley is exposed to an atmosphere containing a large amount of moisture, its germinating capacity is seriously reduced and may even be destroyed entirely. Such a condition of the atmosphere exists in North-eastern India during the period of the monsoon, *i.e.* after May, and consequently the germinating power of barley shipped from Calcutta after May is liable to be low. Barley produced in North-western and Central India would not meet with adverse conditions at any time, and although the humidity of the atmosphere along the sea-board area from Karachi to Bombay is high after May, barley exported at that period from these ports would not suffer appreciably if it were not delayed long in the sea-board area. In 1912–13 nearly 300,000 tons of barley, of a total value of about $1\frac{3}{4}$ million pounds sterling, were shipped from the various ports; about two-thirds from Karachi, slightly less than one-third from Calcutta, and a small quantity from Bombay. No barley has been exported to this country from India during the last three or four years, but when shipments are again made, the results of this work should be borne in mind.

PALÆOBOTANY AND EARTH-HISTORY.—The importance of the correct determination of fossil plants from the point of view of stratigraphers is well brought out in two short papers by Prof. A. C. Seward in the Quarterly Journal of the Geological Society of London, vol. 78, part 3, Sept. 1922. In one, the first fossil plants recorded from Ceylon are described, from specimens collected in dense jungle by Mr. E. J. Wayland. They prove the existence of Middle Jurassic strata, comparable with those of Madras. The second paper deals with Carboniferous plants collected by Mr. J. A. Douglas on the west coast of Peru. Dr. F. Fuchs recorded plants from this locality as Carboniferous in 1900, but he included two Wealden species, which Prof. Seward is inclined to reject in the absence of further evidence. If the list now given could be regarded as representing a flora of Upper Carboniferous age, its north-European affinities and the absence of any member of the Glossopteris flora would give it special significance. Prof. Seward, however, states that it may be Lower Carboniferous. Mr. J. A. Douglas, in the discussion on the paper, suggested that a chain comparable in height with that of the existing Andes may have formed an effectual snow-clad barrier between the region supporting the Gondwanaland flora and that yielding a more normal Carboniferous type farther to the west.

AMERICAN VERTEBRATE PALÆONTOLOGY.—A number of short "Contributions from the Paleontological Laboratory" of the Peabody Museum, Yale University, have of late been appearing in the *American Journal of Science* (vols. ii. to iv.). E. L. Troxell, from "A Study of Diceratherium and the Diceratheres," is led to divide the true Diceratherium, Marsh, of the Great Basin of Oregon, from those of the Great Plains of Nebraska and Wyoming, which he refers to a new genus Menoceras, and further to separate both from Aceratherium, Kaup. The same author, treating of "Oligocene Rodents of the genus Ischyromys," hazards the suggestion that this genus developed into the modern prairie-dog, Cynomys. Mr. Troxell has also investigated "the genus Hyrachyus," which he considers divisible into three groups. R. S. Lull supplies a "Restoration of *Blastomeryx marshi*" and discourses on the "Primitive Pecora in the Yale Museum," among which with other novelties is described *Nanotragulus loomisi*, gen.

et sp. nov., from the Miocene of Wyoming. M. R. Thorpe describes a "New genus of Oligocene Hyænodontidæ," from South Dakota, under the name of Neohyænodon. He also discusses the "Oregon Tertiary Canidæ" and "A new Merycoidon" as well as "Aræocyon, a probable old world migrant." The last-named, founded on a jaw from the Middle Pliocene of Oregon, has its nearest ally in *Simocyon primigenius*, Roth, from the Pikermi beds near Athens, and should it prove to be a derivative of purely American ancestry it will, the author considers, be one of the most remarkable cases of convergence known to the science of vertebrate palæontology. Finally, in a more lengthy paper Mr. Thorpe describes "Some Tertiary Carnivora in the Marsh Collection," including new forms.

RAIN-PRODUCING INFLUENCES IN SOUTH AUSTRALIA.—From an examination of the rainfall records and other evidence in South Australia, Mr. E. T. Quayle has come to the conclusion that there is an area of marked rainfall improvement lying south-east from Lake Torrens, where in places it ranges as high as 20 per cent. In the Proceedings of the Royal Society of Victoria, 34 (N.S.), Pt. II., Mr. Quayle discusses the reasons of this improvement and its bearing on the reclamation of arid areas in the interior. The area of improvement in South Australia is continuous with a similar one in Victoria, and both are in contrast to areas of marked decrease to the north. Irrigation as a source of improved rainfall cannot operate in South Australia, for it has made practically no progress. Mr. Quayle finds the causes in changes in vegetation, due to settlement, and to variations in the water supply of the great inland lakes. From various data it would appear that Lake Torrens and Lake Frome are now impounding more water than formerly, but quantitative data are difficult to obtain. Certain places to the south-east or lee of the lake show increased rainfall in recent years, while places beyond its influence show a decrease. The full cause of the increase of water in these lakes is not clear, but Mr Quayle considers that the substitution of cereal crops or grass for Mallee scrub leads to a marked increase in rainfall. The destruction of forest trees and the extension of pastoral lands are aids in local rain production. This matter is of so much importance that it is to be hoped that investigations on a larger scale will be undertaken.

THE LIGNITE OF THE LOUGH NEAGH CLAYS.—Evidence is accumulating to show that the Lough Neagh Clays in the counties of Tyrone and Antrim are of Oligocene rather than Pliocene age. The recent deep boring at Washing Bay has yielded to Prof. Johnson and Miss J. G. Gilmore (Sci. Proc. R. Dublin Soc., vol. 17, p. 59, 1922), through the cores preserved by the Geological Survey, material that calls forth the following interesting remark: "It needs little imagination to picture the presence of forests of Sequoia in N. Ireland, possibly contemporaneous with those in S. Devon at Bovey Tracey, the shores of the Baltic, the Rhine valley, Saxony, Silesia, and S. France. We may yet find in Ireland large deposits of lignite or brown coal of economic value like those abroad."

THE STATEMENT OF CRYSTAL-SYMMETRY.—Numerous minerals are known, the normal crystals of which indicate, on physical measurement, a certain type of symmetry, while the results of treating them with solvents lead to their being placed in another of the thirty-two crystallographic classes. A latent symmetry is thus revealed. E. T. Wherry (*Amer. Journ. Sci.*, vol. 204, p. 237, Sept. 1922) styles such crystals *amphisymmetric*, and regards the symmetry determined with the goniometer as that of the structure built up by the atoms or molecules, and the latent symmetry as that of the separate atoms or molecules, with their attached electrons. This matter is ingeniously stated on p. 241. A halogen atom in sylvine, for example, may receive an electron from a potassium atom, and may then, as a complete octet, be capable of taking its place in a holosymmetric structure. When, however, it is attacked by a solvent, its low surface-symmetry, due to the presence of one electron of metal and seven of halogen, is revealed as the latent symmetry of the substance. Both classes of symmetry should be mentioned in the description of the crystal. Sylvine might thus be described as "Cubic; structurally holosymmetric; latently gyroidal," or "Cubic, structurally of class 32, latently 29." A useful list of amphisymmetric substances is given by the author, including some not known as minerals.

INSULATION TESTING. — Messrs. Evershed and Vignoles, Ltd., of Acton Lane Works, Chiswick, have produced a new insulation tester which possesses several advantages over the older types. Mr. Evershed, who was the first to make a testing set consisting of a small hand dynamo and an ohmmeter, has produced many improvements on the original set during the last thirty years. His greatest improvement was when he made a "one-box" instrument in 1903 and raised the pressures produced by the hand dynamo to 500, 1000, and even higher voltages. This instrument is called the "megger" and has a world-wide reputation. The new instrument is called the "meg" insulation tester. As its weight is only 7 lb. and its dimensions are only $5\frac{1}{2} \times 7\frac{3}{4} \times 6\frac{1}{4}$ inches, it is much lighter and smaller than any similar instrument. The case is made of cast aluminium, one end of which is formed of an oil-tight gear box. It is always ready for use and will stand rough usage. A free-wheel device protects the gear from damage and prevents the armature from being turned the wrong way. At 100 rev. per. min. it generates 500 volts, and considering its size its efficiency is most satisfactory. The price is only about half the price and the weight is less than half the weight of the well-known "megger" testing set.

HEATING AND VENTILATION IN PASSENGER SHIPS.—With the general advance of scientific progress many of the discomforts of sea life have been eliminated. Distilling ensured a plentiful supply of fresh water; electricity solved the problem of lighting, refrigeration that of food preservation. The accommodation of our big ships is often and rightly described as palatial. If there is any problem that has lagged behind it is that of the ventilation and heating of passenger ships, a subject which was dealt with in a paper read by Mr. J. L. Musgrave at the Institution of Heating and Ventilating Engineers on October 11. The problem is admittedly a difficult one. Not only have large numbers of passengers to be accommodated in limited spaces but the conditions of sea life change from day to day. Then, too, odours from the machinery spaces, from the paintwork, store-rooms, kitchen, bathrooms, etc., have to be prevented from reaching the living spaces, and at the same time an ample supply of fresh air, heated or cooled as the case may be, has to be kept in circulation throughout dining saloons and cabins. In his paper the author referred to these things and gave it as his opinion that though shipbuilding firms employ experienced men to design the ventilating and heating arrangements, the co-operation of the fully-qualified heating and ventilating engineer at an early stage of the design of the ship would lead to more satisfactory results, and that expenditure on improved ventilation would prove a profitable investment.

The Hydrogen Molecule.[1]

IN Prof. Crehore's papers on the hydrogen molecule, Saha's theory of electromagnetic forces is made use of, which is founded on the Einstein relativity theory. A certain type of atom is described for hydrogen, consisting of a revolving nucleus of positive electricity with two revolving negative electrons, one on either side of the nucleus, and having a common axis of revolution with it; and it is shown that the resultant of the electrostatic and electrodynamic forces acting at points the distance of which from the atom is great, compared with the distances between the atoms in a crystal, varies inversely as the square of the distance. Gravitational force is thus shown to result from the combination of electrostatic and electrodynamic forces, when relativity is taken into account. The spinning of the positive nucleus, and of the electrons, gives them an ellipsoidal form, the ratio between the major and minor diameters being in each case 3·058. For the negative electron the major diameter is $6{\cdot}514 \times 10^{-13}$ cm. and the minor is $2{\cdot}130 \times 10^{-13}$ cm. The greater part of the mass of the atom resides in the positive nucleus; and, as it is assumed to be wholly of electromagnetic origin, this nucleus is extremely minute in comparison with the negative electron, as in the commonly accepted theory of atomic structure, the solar system theory.

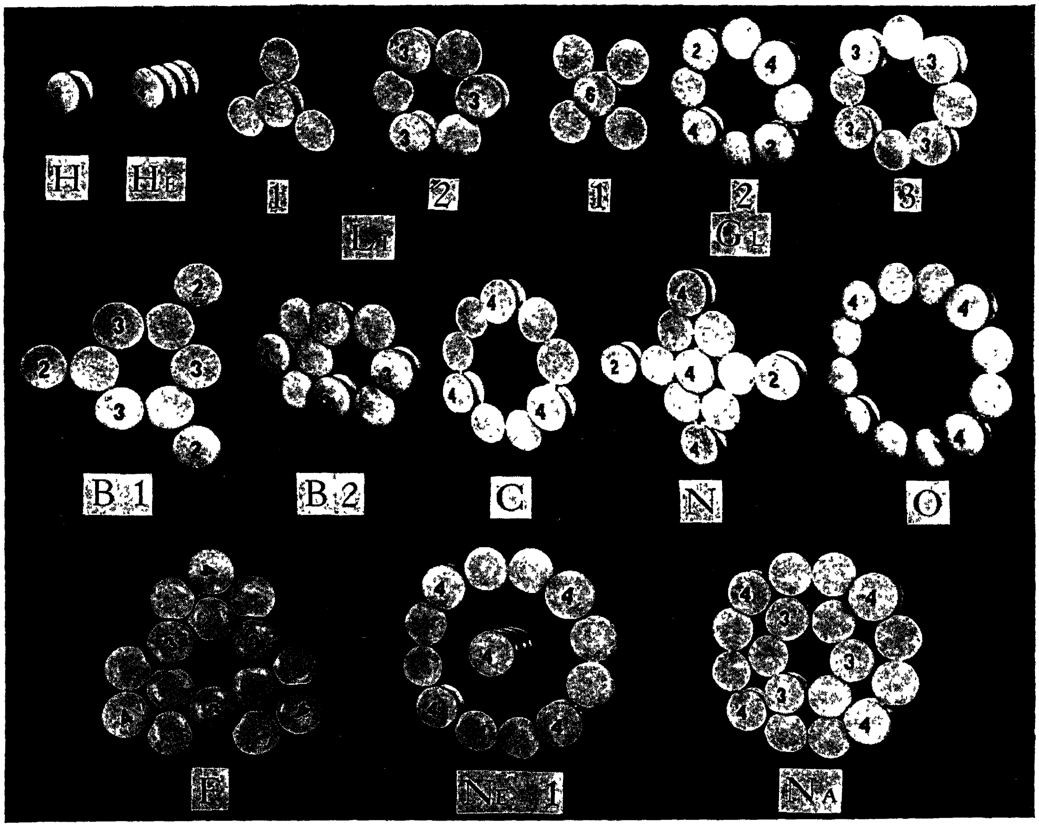

FIG. 1.—H, hydrogen atom; two coaxial, ellipsoidal electrons, on either side of positive electron with charge $+2e$, and mass 1·008. He, helium atom, four coaxial electrons with positive nucleus between them. Li 1, discarded by Crehore. Li 2, three δ particles with three binding electrons representing Li 7, N=3. Gl 1, discarded by Crehore. Gl 2 and 3 do not represent observed isotopes. B_1 and B_2, isotopes of boron B_{10} and B_{11}. C, carbon with six binding electrons corresponding to the atomic number of the element, N=6. O, oxygen, N=8, eight binding electrons. F, fluorine, N=9, nine binding electrons. Ne 1, Ne 20; the helium atom at the centre is supposed to be equivalent to an addition of two binding electrons. Na, sodium, N=11, eleven binding electrons.

In the hydrogen atom, when a disturbance takes place, the electrons will move a certain distance along the common axis about which they and the positive ellipsoid are rotating, away from the latter; and will then return to their original position. Crehore is of opinion that it will be possible, in this way, to account for the emission of various kinds of monochromatic light from the atom, and that the existence of definite quanta of luminous energy may be explained. He contemplates the adaptation of the whole of the mathematics of Planck and of Bohr to his special form of atom.

The action of one hydrogen atom upon another, at a distance from it, is investigated, with the restriction that the axes of rotation are parallel to one another. Mathematical evidence is obtained of the possibility of certain definite positions of equilibrium for the second atom, in the field of the first, so that the two are bound together to form a molecule. Their distance apart appears to be of the order of 10^{-8} cm., or enormously large, when compared with the size of the atoms. The distance is of the same order as the distances between the atoms of crystals; and it is to be supposed that similar relations to those between two hydrogen atoms, in a hydrogen molecule, exist between the atoms of sodium and chlorine, in sodium chloride; and that a number of such atoms are linked up, in

[1] Prof. A. C. Crehore, *Phil. Mag.*, Oct. 1921, May 1922, June 1922.

this way, into a large compound molecule or crystal. Crehore hopes that his theory will be found capable of explaining all the properties of matter, chemical affinity, valency, and the electric and magnetic properties.

Prof. Crehore has constructed a number of models consisting of wooden ellipsoids, which represent electrons, to show the structure which he assigns to the atoms of a number of elements, including several of the isotopes, which have been observed, and the atomic weights of which have been determined by Aston and Fowler, with the positive ray spectrograph. Reproductions of some of these models appear in Fig. 1; and they account for the observed atomic weights of the different elements, including those of the isotopes as determined by Aston and Fowler. The positive nuclei do not appear in the models, as the ellipsoids of revolution representing them are very minute compared with the negative electrons. Crehore assumes the existence of three different kinds of positive nuclei; those of hydrogen, with charge $+2e$ and mass 1·008; those of helium, with charge $+4e$ and mass four; and those of a hypothetical element with charge $+3e$ and mass 2·333. In building the models these nuclei are combined with electrons as follows, to form positively charged particles; (1) that of hydrogen, with one negative electron, giving a particle H′, with charge $+e$, and marked 2 in the models to show that the charge of its nucleus is $+2e$; (2) that of helium, with two negative electrons, giving an α particle with charge $+2e$, marked 4 in the models, as the charge of its nucleus is $+4e$; (3) that of helium, with three electrons, giving a particle with charge $+e$; (4) that of the hypothetical element, with mass $2\frac{1}{3}$, together with two electrons, positive charge $+e$ and marked 3 in the models.

Calling this δ, the isotope of lithium (Li 7), with atomic weight 7, is formed by a ring of three δ particles, joined by three electrons, which may be shown developed into a straight line as $-\delta-\delta-\delta\ldots$, the full hyphens representing the binding electrons. Beryllium is assigned the structure $-4-2-4-$, the two 4 particles being joined by two electrons, and the atomic weight being nine. Be 10 is a ring $-\gamma-\mathrm{H}'-\gamma-\mathrm{H}'\ldots$ Carbon is represented as $=\alpha=\alpha=\alpha::$:, oxygen as $=\alpha=\alpha=\alpha=\alpha:::$:, and neon as the same ring of four α particles, with a helium atom at its centre, the common axis of the four negative electrons and one positive particle of the helium being at right angles to the plane of the ring.

It will be understood that the γ particle is obtained from helium by removing one electron, and the α particle by removing another, from the other end of the axis, about which the electrons and the positive particle are regarded as rotating. The H′ particle, with charge $+e$, is obtained from Crehore's hydrogen atom by removing one of the two electrons on either side of the nucleus, and the δ particle will have two electrons, one on either side of the nucleus, and rotating about its axis. These α, γ, H′, and δ particles are held together by binding electrons to form the atomic models described above. The atomic number is in general equal to the number of the binding electrons.

Athletics and Oxygen Supply.

IN attempting to analyse the factors which underlie muscular efficiency, most observers have been content to concern themselves with a consideration of the oxygen supply. They have devoted themselves to a study of the means by which fuel arrives at the engine rather than to a study of the behaviour of the engine itself. As a result of the work of Fletcher, Hopkins, and of Hill, we are now in a position to consider the broad question of athletic capacity from the details of the changes which we know take place in the contraction of a single isolated muscle.

We know that during the initial contraction of the muscle and the period in which this contraction is maintained, there is a liberation of lactic acid within the muscle, and that the actual contraction of the muscle is a consequence of the physical forces called into play by the appearance of this acid at various membranes or surfaces within it. The fact of great significance is that these processes in which the full force of the muscle is developed and maintained do not demand for their accomplishment any supply of oxygen whatever. While the muscle relaxes the lactic acid present is neutralised by the supplies of available alkali in the tissues, but not until the period after relaxation is complete does the oxygen consumption of the muscle begin. In this final stage, in which the muscle is apparently at rest, a process goes on which may be compared to the recharging of an accumulator, for not only is oxygen consumed but the lactic acid disappears and heat is developed.

A little reflection is sufficient to help us to realise that the sequence of changes in the isolated single muscle, in which the oxygen consumption only occurs during the final stage, has its counterpart in the processes going on in the body of a man running a race. When the running stops, he is "out of breath," that is to say he still needs oxygen in excess of his resting requirements, for he does not, from minute to minute during the race, obtain all the oxygen necessary to oxidise the lactic acid produced in the contractions of his muscles. If he runs slowly the process of removing lactic acid will be correspondingly facilitated, for his oxygen intake will be nearly sufficient to deal with all the lactic acid produced. If, however, he runs quickly, while he does not increase his oxygen intake, he does increase his lactic acid production, and this production will soon outstrip its removal. In other words, the runner will become fatigued. Fatigue, then, is seen to be due, among other things, to the accumulation of lactic acid in the muscle, and the extent of a man's capacity as an athlete depends on the extent to which he can tolerate such an accumulation. His toleration for lactic acid will depend on the reserve of alkali which his tissues contain for neutralisation of this acid.

Prof. A. V. Hill, in a paper read before the Section of Physiology of the British Association at the recent meeting at Hull, was at some pains to point out the errors into which various observers have fallen by neglecting the oxygen consumption which takes place after running stops. They have assumed that the oxygen consumption per minute during the running represented the total energy requirement, and have in some cases arrived at the absurdity that quicker rates of running require less oxygen than do slower rates. Yet it is precisely *because* the oxygen consumption can to a certain extent lag behind the development of energy, it is *because* the isolated muscle can exert its full strength in the absence of oxygen, that a man can run 100 yards at a much greater speed than he can run 1 mile.

An interesting confirmation of the view that fatigue is due to the accumulation of lactic acid in the muscles is obtained by considering the fact that

a man of athletic frame can "run himself out" to such an extent that he requires 10 litres of oxygen at the end of exercise above his resting consumption, he will absorb this amount during the 8-10 minutes which follow the end of the exercise. Now the amount of lactic acid which this oxygen will oxidise can be calculated, and on the assumption that a man of 70 kgm. weight is using 25 kgm. of muscle, the calculation indicates that when an athletic man is exhausted, the lactic acid present will amount to 0·33 per cent. of his muscle weight. But Meyerhof has determined that the maximum percentage of lactic acid which can be produced by stimulation in isolated mammalian muscle varies from 0·3 to 0·4 per cent. The agreement between the two figures is very striking.

The fact that a runner does not consume all the oxygen he requires for running until the exercise is over may be regarded in another light. One may say that the runner gets credit for oxygen. Let us suppose that before exhaustion he can get credit for 10 litres. Then, if during exercise he breathes in 5 litres per minute, it follows that in running for 1 minute he has energy corresponding to 15 litres of oxygen at his disposal. In running for 5 minutes, however, the energy available only corresponds to $(10+5\times5=)$ 35 litres of oxygen; that is to say, it corresponds to 7 litres per minute. Roughly speaking, the energy available per minute when running 5 minutes is less than half that available when running only 1 minute.

It was found to be possible to plot a curve showing the relation of the true oxygen consumption in running various distances at a maximum rate to the time taken. The distances chosen were those of the customary flat races. It was found that the curve was of the same general type as that obtained when the speed developed in the various world's records was plotted against the time taken. In other words, it was evident that the shape of this latter curve could have been predicted from considerations of oxygen consumption.

The Fiftieth Anniversary of the Dutch Zoological Society.

THE fiftieth anniversary of the foundation of the Nederlandsche Dierkundige Vereeniging, which was celebrated at Amsterdam on September 24 and 25, was an event of much scientific interest.

At the meeting held in the large hall of the Amsterdam Zoological Gardens ("Natura magistra Artis") the president, Prof. J. F. van Bemmelen, of the University of Groningen, delivered an interesting address on the history of the Society. He referred in the course of his address to the important part the Society has played in the scientific investigation of the Dutch marine fauna and flora and in the establishment of the permanent Marine Biological Station at Helder, to the activity it has shown in the movements for the preservation and protection of native wild animals and to its association, in an advisory capacity, with Dutch Government Departments on questions concerning the scientific development and regulation of the marine and fresh-water fisheries.

At the conclusion of his address the following were admitted Honorary Members of the Society: Prof. O. Abel, Vienna; Prof. M. Caullery, Paris; Prof. L. Dollo, Brussels; Prof. B. Grassi, Rome; Prof. V. Häcker, Halle; Prof. S. J. Hickson, Manchester; Prof. N. Holmgren, Stockholm.; Prof. T. H. Morgan, New York; Dr. F. Sarasin, Basle; Dr. J. Schmidt, Copenhagen.

On the following day, September 25, a large party of the members with their foreign guests set forth from Amsterdam in a steamboat through some of the most interesting and beautiful waterways of that part of the country to visit the new Fresh-water Biological Laboratory stationed in the river Vecht near Vreeland. A large and commodious houseboat called the *Meerval* has been fitted up with aquaria, dredging apparatus and other appliances for systematic and biometrical investigations of the fresh-water fauna, and there is sleeping accommodation for two or three investigators and the staff. The *Meerval* can be moved about from place to place during the summer months and is laid up for the winter at Helder.

The party was received on board the *Meerval* by Dr. Redeke, the director of the Marine Biological Station and Inspector of Fisheries, who gave an account of the investigations in progress and explained the exhibits and apparatus that were displayed.

One important result of the activities of Dr. Redeke and his assistants will be the publication of periodical reports on the fauna and flora of the Zuider Zee, and particularly of that part of it which is threatened with destruction by draining. An advanced copy of the first number of these reports was shown to the visitors.

The members of the society and their guests were entertained on the Sunday night at a banquet in Amsterdam, and on the Monday were the guests of Dr. and Mrs. Redeke at lunch at Vreeland.

It was unfortunate that Prof. Caullery (Paris), Prof. Dollo (Brussels), Prof. Grassi (Rome), Prof. Morgan (New York), and Dr. Schmidt (Copenhagen) were unable to attend the celebrations; but the foreign guests who were present thoroughly enjoyed the opportunity thus given to them by their most hospitable Dutch hosts of an interchange of views on zoological problems with friends and colleagues they had not met since pre-war days.

We may congratulate the Dutch Zoological Society on the attainment of its fiftieth anniversary, and on the valuable scientific work it has accomplished since its foundation.

Processes of Rock-Formation.

IN a long communication sent to us by Mr. J. H. Goodchild, dealing with the distribution of sodium and calcium, reference is made to Prof. J. Joly's calculation of the age of the earth from the saltness of the sea, a calculation based on the assumption that the salt in the sea has been carried there by streams and rivers and has been derived by solution from the land. In opposition to this view Mr. Goodchild suggests that, contrary to the notions held at the present day by geologists, salts pass from the ocean to the land, and are being fixed as new mineral combinations in the rocks through which they percolate. He regards sedimentary rocks, such as sandstone and shale, as unstable, and liable to admixture with one another as well as to modification by the action of soluble substances like salt and calcium carbonate. As examples of changes of this sort he points to the dolomitisation of limestone, the

formation of hæmatite at and near the surface, concretions in the coal measures, and vein formations of quartz, calcite, fluorspar, and barytes.

Mr. Goodchild extends this conception to the formation of metamorphic rocks, which he regards as being formed by the action of percolating solutions on unstable strata, the action of heat and pressure being an accompaniment rather than, as petrologists usually assume, the cause of the metamorphism. From this position, assuming the formation of aluminium silicates at low temperatures, Mr. Goodchild has no difficulty in explaining the formation of basalt and other igneous rocks as due to the local but intensive action on sedimentary rocks such as sandstone, shale, and limestone of solutions containing sodium, potassium, magnesium, and calcium. Hence where igneous rocks are found associated with sedimentary rocks Mr. Goodchild regards the former not as pre-existing igneous or other rocks that have been melted by heat and injected into the sediments in a molten state, but rather as portions of the sediments that have been altered locally by interaction with one another and with percolating solutions.

According to Mr. Goodchild, rock-changes in temperate climates show ample evidence of the process to which he refers, but he states that these changes are best seen under tropical conditions. He makes a strong plea for the representation in colour of tropical conditions of weathering, by artists imbued with a sense of mystery, as a means whereby observers in temperate climates may be brought to realise the real nature of the processes involved in metamorphism and the origin of igneous rocks.

For fuller details as to Mr. Goodchild's views, reference may be made to papers on "Laterization in Minas Geraes, Brazil" (Trans. Inst. Min. Met., 1914, vol. 23, p. 3), and "Land Growth" (*Mining Magazine*, 1921, vol. 25, p. 75).

University and Educational Intelligence.

BIRMINGHAM.—We recently announced in this column the appointment of Mr. K. N. Moss as professor of coal- and metal-mining. This appointment has now been followed by the creation of a chair of petroleum-mining, to which Mr. R. R. Thompson has been elected. Prof. Thompson was on the staff of the mining department of the University during the session 1911–12, since when he has had experience of oil-mining in Persia, Burma, and elsewhere. He has recently been Director of Lands and Mines in Trinidad, a post which he relinquished to come to Birmingham. Sir John Cadman continues to act as honorary adviser to the mining department, and with Dr. Haldane as director of Coal-mining Research, the University takes a very high place as a centre of instruction in mining in the British Empire.

CAMBRIDGE.—Prof. H. R. Dean, professor of pathology, has been elected to a professorial fellowship at Trinity Hall. Prof. R. M. Dawkins, of Oxford University, formerly director of the British School at Athens, has been elected to an honorary fellowship at Emmanuel College, where he was formerly a fellow. The Master of Jesus College has been appointed to represent the University on a grand committee established to make arrangements for the commemoration next February of the bicentenary of the death of Sir Christopher Wren.

Mr. F. G. Mann, Downing College, has been appointed assistant to the professor of chemistry. The Gedge Prize has been awarded to F. J. W. Roughton, Trinity College, for an essay on "Some Blood Gas Problems."

LONDON.—At a meeting of the Senate held on October 18, a communication was received from the Minister of Health forwarding draft heads of agreement with reference to the School of Hygiene which is to be established as a School of the University with the donation of two million dollars made for the purpose by the Rockefeller Foundation. These provide for the erection of suitable buildings on a site in Bloomsbury and the constitution of a Board of Management and a Court of Governors for the control and administration of the School. Resolutions were adopted expressing the concurrence of the University in the proposed scheme, and the very great satisfaction with which the Senate have learnt of the munificent contribution of the Rockefeller Foundation and of the intentions of the Government with regard to the maintenance of the School.

To a communication from the Clerk of the London County Council intimating the desire of the Council that the question of the Bloomsbury site for the University should be reopened, the Vice-Chancellor was requested to reply that the Senate is prepared, "should His Majesty's Government wish to explore the possibilities of the Holland Park Site or any other site in conjunction with the University, to co-operate with the Government for that purpose."

The thanks of the Senate were accorded to the Essex County Council for a grant of 500*l.* for the year 1922–1923 for distribution among the Schools of the University in the Faculties of Arts, Science, Engineering, and Economics in proportion to the number of full-time day students from that county in attendance at those Schools; also to the Stansfeld Trustees for a second donation of 40*l.* for the provision of a Stansfeld lecture to be delivered on the laws and customs affecting the relationship between men and women.

The following doctorates were conferred: *D.Sc. in Chemistry*: Mr. S. S. Bhatnagar, of University College, for a thesis entitled "Studies in Emulsions and Surface Tensions"; Mr. F. C. Toy, of University College, for a thesis entitled "Investigations of the Photographic Process"; and Mr. H. Moore, for a thesis entitled "The Influence of Chromium on Steel," and other papers; *D.Sc. in Physics*: Mr. Snehamay Datta, of the Imperial College, Royal College of Science, for a thesis embodying the results of various researches in spectroscopy

A course of eight free public lectures on "Secretion and Internal Secretion" will be delivered by Prof. Swale Vincent on November 6, 9, 13, 16, 20, 23, 27, and 30, at 5 o'clock, in the Physiology Lecture Theatre, Middlesex Hospital Medical School, Union Street, W.1. No tickets will be required.

A CONFERENCE on the report of the committee appointed by the president of the Board of Education to inquire into the position of English in the educational system of England will be held at Birkbeck College, Bream's Buildings, Chancery Lane, E.C.4, on Thursday, November 2, at 4.30. The chair will be taken by Sir Cyril Jackson, chairman of the Education Committee of the London Council.

THE University of Bristol Association of Alumni (London branch) has arranged to hold an inaugural dinner at La Renommée Restaurant, 52 Dean Street, Shaftesbury Avenue, London, on Monday, November 6, at 7.30 P.M. Lord Haldane is the president of this branch, and it is hoped that a large number of members of the University, both past and present, will be at this dinner. The Vice-Chancellor and Mrs. Loveday have already accepted an invitation to attend.

Calendar of Industrial Pioneers.

October 29, 1874. John Laird died.—One of the chief pioneers of iron shipbuilding, Laird, who was born in Greenock in 1805, was the son of William Laird, who established a boiler-making works at Birkenhead. As a partner with his father, in 1829 he built an iron lighter of 60 tons, and in 1833 built the iron paddle steamer *Lady Lansdowne*. Laird also built the first iron vessel in the Royal Navy, and in 1839 built the *Nemesis* for the East India Company, the first iron steamer to carry a gun and to steam round the Cape. The famous Birkenhead Iron Works were established by him.

October 30, 1823. Edmund Cartwright died.—The inventor of the power loom, which he brought out in 1785, Cartwright was born in the Midlands in 1743, was a student of University College, Oxford, and entered the Church. While holding the living of Goadby-Marwood in Leicestershire a visit to Arkwright at Matlock turned his attention to weaving, and within a year he had made the great invention by which he is remembered. His loom was employed but little till the 19th century, but in 1809 he was granted a sum of 10,000*l*. by Parliament. Cartwright also made improvements in woolcombing and in agriculture, and assisted Fulton in some of his experiments in steam navigation.

October 30, 1880. Sir Thomas Bouch died.—Born in Cumberland in 1822, Bouch was trained as a railway engineer and in 1849 became manager of the Edinburgh and Northern Railway. He constructed some 300 miles of railway, instituted steam ferries on the Forth and Tay, and between 1870 and 1877 built the first Tay Bridge, nearly two miles long. This bridge consisted of 85 spans, some of the wrought-iron lattice girders being 245 feet long. It was completed in September 1877, and opened for traffic in May 1878. During a hurricane on the evening of December 28, 1879, the central portion with an entire train and 70 passengers fell into the Tay.

October 30, 1898. Josiah Latimer Clark died.—A distinguished electrical engineer, Clark began life as a chemist, and after engaging in railway work, in 1850 joined the Electric and International Telegraph Company. His principal work lay in the field of submarine telegraphy and he was concerned with the laying of many cables, mainly in the East. He was also an original investigator, assisted to found the Institute of Electrical Engineers, and in 1874–75 served as president.

November 1, 1856. John Urpeth Rastrick died.—Trained under his father as a mechanical engineer, Rastrick took an important part in introducing railways into the country. He effected improvements in locomotives, was one of the judges at the Rainhill trials of 1829 who decided in favour of Stephenson's *Rocket*, assisted Stephenson to survey the Birmingham and Manchester Railway, and with Sir John Rennie was engineer to the London and Brighton line.

November 4, 1917. William Du Bois Duddell died.—Recognised as a brilliant investigator of electrical phenomena, Duddell was trained as an engineer at Colchester and then worked under Ayrton at the Central Technical College, London. His discovery of the singing arc formed the starting point in the development of the Poulsen arc, while his oscillograph marked an epoch in the experimental investigation of alternating current phenomena. He was a Fellow of the Royal Society and served as president of the Röntgen Society and of the Institution of Electrical Engineers. E. C. S.

Societies and Academies.

LONDON.

Optical Society, October 12.—Prof. F. J. Cheshire, vice-president, in the chair.—L. C. **Martin**: A physical study of coma. A specially designed microscope objective and mounting, calculated to exhibit coma in the absence of spherical aberration and astigmatism, are described. Photographs of a star image, taken when the amount of coma is equivalent to that for which the light distribution has been calculated, verify the numerical work. The photometric examination of the photographic image is carried out by a special method.—F. W. **Preston**: Comparison of the structure of sand-blasted and ground glass surfaces. Glass surfaces smoothed or "greyed" by loose abrasives in the usual way are compared with those produced by sand blasting. The surfaces are practically indistinguishable either by the naked eye or the microscope, and the development of the structure by etching shows that the structure is virtually identical. Thus it appears that mere pounding of a glass plate can, and does, produce a surface which is structurally indistinguishable from a smoothed surface of a technical order.

PARIS.

Academy of Sciences, September 18.—M. Emile Roux in the chair.—L. **Cuénot** and Raymond **Poisson**: The development of some coaptations of insects. Coaptations are defined as mechanical arrangements formed by the reciprocal adjustment of two independent parts, like a key and a lock. Examples of such processes are given from *Nepa cinerea* and *Ranatra linearis*.—L. G. **Du Pasquier**: The arithnomy of quaternions.—Jean **Rey**: The probability of illuminating an aeroplane by the beam from an electric projector.—A. **Sanfourche**: The reactions between the gaseous oxides of nitrogen and alkaline solutions. The reaction generally assumed to take place occurs only when the alkali is in excess at every point. If there is any local deficiency of alkali, the gas reacts with water producing nitric acid and nitric oxide. Sulphuric acid is preferable as an absorbent.—Paul **Riou**: The velocity of absorption of carbon dioxide by ammoniacal solutions. Experimental results on the velocity of absorption of carbon dioxide by solutions of ammonium carbonate, with varying concentrations of salt and with varying temperatures.—P. **Russo**: New indications of the Trias in eastern Morocco.—Jean **Bathellier**: The rôle of the soldiers in *Eutermes matangensis*. In fighting, the soldiers of this species eject a sticky fluid, insoluble in water, which rapidly reduces their opponents to immobility. If the nest is broken, the workers are protected during the process of reconstruction by a line of soldiers, which follows the contour of the gallery under repair.—F. **Dienert** and P. **Etrillard**: The possibility of the existence of organisms in rocks capable of reviving after sterilisation by heat. A repetition of some experiments by M. Galippe. The results of M. Galippe were not confirmed: the rocks were sterile after prolonged heating to 180° C.

September 25.—M. L. Maquenne in the chair.—The Perpetual Secretary announced the death of M. Battandier, correspondant for the section of Botany.—P. **Urysohn**: The ramification of the Cantorian lines.—M. **Seigle**: The principal characteristics of mild steel bars previously broken by traction. It has been generally held that a steel hardened by extension is breakable and dangerous to use. Tests

on bars of mild steel broken by pulling show that this view is not exact. Details of the various tests to which the bars were submitted are given.—P. **Chevenard**: Nickel alloys retaining their rigidity over an extended temperature range. The alloy in the form of wire was heated to a constant temperature and loaded with a weight: an automatic arrangement recorded photographically the elongation as a function of the time. Curves are given for nickel, electrolytic iron, and for four alloys. A nickel-chromium-tungsten alloy was the most resistant to high temperatures.—L. J. **Simon**: The direct oxidation by oxygen or air of the esters of the alcohol acids. Methyl, ethyl, butyl, and amyl lactates when heated in a current of air undergo oxidation, giving the pyruvates in notable proportion. Ethyl glyoxylate can similarly be recognised as one of the products of oxidation by air of ethyl glycollate.—E. **Fournier**: The nature and structure of the substratum of the Jura chain. An account of the strata pierced by an experimental boring at Chazelot (near Rougemont) carried to a depth of 700 metres.—L. **Eblé**: Magnetic measurements in the Paris basin. The results given for 41 stations form part of a new magnetic survey of France. The secular variation of the magnetic elements between January 1, 1896, and January 1, 1922, was practically the same for all the stations; the mean values were: declination $-2^\circ 58'$, inclination $-0^\circ 32'$, horizontal component $+0{\cdot}0014$. These are almost exactly the values obtained at the central station of Val-Joyeux.—Marcel **Mirande**: The influence of light on the formation of anthocyanine in the scales of the bulbs of lilies. It has been shown experimentally that the only radiations taking an active part in the reddening of the scales are those in the luminous part of the spectrum: there is a first maximum effect in the red, a much more important maximum in the indigo blue, and a minimum in the green.—L. **Berger**: The existence of an ovarian gland, homologous with the testicular interstitial gland.—L. **Carrère**: The dilator of the pupil in the selacians.—Paul **Wintrebert**: The cartilaginous pterygoid in the urodeles.

SYDNEY.

Royal Society of New South Wales, September 6.—Mr. C. A. Sussmilch, president, in the chair.—R. H. **Cambage**: Acacia seedlings, Pt. VIII. A number of seedlings of different species were described. A seed of *Acacia melanoxylon* germinated after having been continuously immersed in sea water for five years. The phyllodes of various species of Acacia, such as *A. conferta*, *A. elongata*, *A. floribunda*, and *A. longifolia*, close up towards the stem at night.—M. B. **Welch**: Relationship between oil glands and oil yields in the Eucalyptus. Measurements made of the oil glands in the leaves of different Eucalypts show that the oil yield on distillation is not absolutely dependent on the number and size of the oil glands.—S. **Dodd**: Poisoning of sheep by *Solanum cinereum*. Feeding experiments proved the berries to be very poisonous. The active principle is probably solanin. Half a pound of dried ripe berries given whole were innocuous, but the same amount mashed with water caused death to sheep in six hours. The probable reason for this is that when dry and whole they passed into the rumen, where they became mixed with other food; at the end of each rumination the total amount of fruits re-swallowed was insufficient to produce poisoning. In the other case the soluble alkaloid passed direct into the digestive stomach, etc., and the amount absorbed, being lethal, death resulted.

Diary of Societies.

MONDAY, OCTOBER 30.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. Shattock: Specimens of Foreign Bodies.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—W. B. Appleton: Past and Present Methods of making Photographic Lenses.

TUESDAY, OCTOBER 31.

ROYAL HORTICULTURAL SOCIETY, at 3.—C. T. Musgrave: Methods of Propagation in an Amateur's Garden.

WEDNESDAY, NOVEMBER 1.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—C. Ainsworth Mitchell: The Colorimetric Estimation of Pyrogallol, Gallotannin, and Gallic Acid.—Dr. H. E. Annett and M. N. Bose: The Estimation of Narcotine and Papaverine in Opium.—J. R. Nicholls: The Estimation of Morphine.—R. L. Morris: Further Notes on the Estimation of Potassium; by Perchlorate and Cobaltinitrite Methods.

THURSDAY, NOVEMBER 2.

ROYAL SOCIETY, at 4.30.—*Probable Papers*.—Lord Rayleigh: Polarisation of the Light scattered by Mercury Vapour near the Resonance Periodicity.—Prof. G. P. Thomson: The Scattering of Hydrogen Positive Rays and the Existence of a powerful Field of Force in the Hydrogen Molecule.—H. D. Smyth: A new Method for studying Ionising Potentials.—I. Backhurst: Variation of the Intensity of reflected X-radiation with the Temperature of the Crystal.—S. Datta: The Absorption Spectrum of Potassium Vapour.—K. R. Ramanathan: The Molecular Scattering of Light in Vapours and in Liquids and its Relation to the Opalescence observed in the Critical State.
LINNEAN SOCIETY, at 5.
ROYAL COLLEGE OF PHYSICIANS, at 5.—Sir Maurice Craig: Mental Symptoms in Physical Disease (Bradshaw Lecture).
ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Major A. R. Low: A Review of Airscrew and Helicopter Theory, with Aeroplane Analogies.
CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Dr. P. B. Ballard: A Defence of Mental Tests.
INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—F. Gill: Inaugural Presidential Address.
CHEMICAL SOCIETY, at 8.—N. V. Sidgwick and W. M. Dash: The Solubility and Volatility of the Nitrobenzaldehydes.—R. H. Pickard, J. Kenyon, and H. Hunter: Investigations on the Dependence of Rotatory Power on Chemical Constitution. Part XIII. The Spatial Configuration of the Unbranched Aliphatic Chain.—J. Kenyon and R. A. M'Nicol: Investigations on the Dependence of Rotatory Power on Chemical Constitution. Part XIV. The Normal Aliphatic Ethers of *d*-β-octanol.—H. Phillips: Investigations of the Dependence of Rotatory Power on Chemical Constitution. Part XV. The Normal Aliphatic Ethers of *d*-methylbenzylcarbinol.—H. Phillips: Investigations on the Dependence of Rotatory Power on Chemical Constitution. Part XVI. A new type of Walden Inversion.—L. Hall: Investigations on the Dependence of Rotatory Power on Chemical Constitution. Part XVII. The *di-d*-β-octyl Esters of the Acids of the General Formula $(CH_2)_n(COOH)_2$.—F. L. Pyman: Orientation of the 1:4- and 1:5-dimethylglyoxalines. Mode of Fission of 5-aminoglyoxalines.—L. Light and F. L. Pyman: Bromo-derivatives of 2-methylglyoxaline.
INSTITUTION OF BRITISH FOUNDRYMEN (at Institute of Marine Engineers), at 8.—F. A. Melmoth: Notes on the Development of the Manufacture of Steel Castings.

FRIDAY, NOVEMBER 3.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Sir Frank Baines: Repairs to the Roof of Westminster Hall.
JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—T. H. Sanders: Laminated Springs.

PUBLIC LECTURES.

SATURDAY, OCTOBER 28.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—F. Balfour-Browne: The Life and Habits of Mason Wasps.

MONDAY, OCTOBER 30.

CITY OF LONDON Y.M.C.A. (186 Aldersgate Street), at 6.—Sir William M. Bayliss: The Unity of the Human Body.

WEDNESDAY, NOVEMBER 1.

UNIVERSITY COLLEGE, at 5.30.—Dr. P. Harting: Holland, the Land and its People.—S. Jones: Some Recent Results in Experimental Phonetics.

THURSDAY, NOVEMBER 2.

FINSBURY TECHNICAL COLLEGE, at 4.—Prof. C. H. Desch: The Metallurgical Chemist (Streatfeild Memorial Lecture).
UNIVERSITY COLLEGE (in Physics Lecture Theatre), at 5.30.—Prof. E. G. Coker: Recent Photo-Elasticity Researches in Engineering Problems.
CITY OF LONDON Y.M.C.A. (186 Aldersgate Street), at 6.—Prof. H. Maxwell-Lefroy: How Insect Pests are tackled.

FRIDAY, NOVEMBER 3.

BEDFORD COLLEGE FOR WOMEN, at 5.30.—Miss C. A. J. Skeel: Ancient Travel.
UNIVERSITY COLLEGE, at 8.—Prof. G. Dawes Hicks: The Philosophy of Religion. Succeeding Lectures on November 10, 17, 24, December 1 and 8.

SATURDAY, NOVEMBER 4.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—E. Lovett: The Folk-lore of the Cat.

SATURDAY, NOVEMBER 4, 1922.

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Primitive Custom and Administration.

THE Report of the Tanganyika Territory for the year 1921, which has been issued as a White Paper (Cmd. 1732), contains much matter of interest relating to native affairs. It is evident that the Administration by sympathetic treatment and by a patient hearing of tribal grievances is winning the confidence of the native population, while every opportunity is being seized to remove hardships which have been inflicted on them by the excessive alienation of land under the German colonial system. As a census taken in April last shows that there is a native population of 4,107,000, the responsibility for the regulation of native affairs is not light. It is satisfactory, therefore, to note that a good beginning has been made towards establishing sympathetic relations with the tribes. In the interests of the Territory, it is vital that the administration should be conducted with due regard to native customs and institutions. It is even more important that the native should have an opportunity of development along lines in harmony with his own culture, and ultimately, it is permissible to hope, of incorporation as an essential and responsible element in the community.

In this connexion a reference in the report to native beliefs assumes a significance which might, perhaps, be overlooked. It is stated that in the Mwanza region the reigning chief has lost his authority through having failed to live up to his father's reputation as a rain-maker, and that witch-doctors are losing their hold over the younger generation. These statements do more than throw an interesting light on the religious beliefs of the people. The combination of function of chief and rain-maker is not uncommon throughout Africa. It is one of the marks of "the divinity that doth hedge a king" among primitive peoples. Its special significance lies in the fact that not only is the person of the king or chief sacred, but his authority also rests upon his power as a sacred being, of which rain-making is one of the manifestations. The magic of the witch-doctor or medicine-man, like that of the king, is on the side of law and order, notwithstanding the, to us, sinister character of certain of his activities. Some of the great secret societies of West Africa, which are essentially religious in character, have, as one of their more important functions, the policing of their respective districts and the punishment of any transgression of the moral or social code. It follows, therefore, that any change in attitude towards the religious beliefs which form the basis of authority cannot fail to have a harmful effect on the discipline of the community. Any indication of a weakening in the regard

which the natives of Tanganyika have for the magic powers of their chiefs and witch-doctors must cause misgiving. It indicates a decay of custom which may effect the most vital elements in native culture and social organisation.

A part of the Empire far distant from Central Africa affords a striking example of a decay of custom similar to that now taking place in Tanganyika. Over the greater part of the South Seas the sacrosanct character of the chief is, or was, the basis of the whole social order. The sacred power of the chief was the sanction of the law, and in virtue of it he punished offenders. Contact with civilisation has proved fatal. The white man does not recognise the sanctity of the chief, nor does he discriminate in this respect between the chief and the ordinary members of the tribe. When he commits, without fatal consequences, acts which the native regards as tabu, the sacred character of the chief is impaired and his authority undermined. As the laws of morality, of the sanctity of married life, and of property rest on the principle of tabu, of which the chief is the supreme manifestation, not only is the authority of the chief to punish offenders questioned, but the whole social order is also disintegrated. The results can be studied in Melanesia, and particularly in the New Hebrides, where contact with the white man has led to the discrediting in this way of the authority of the chief and of the elders of the community.

The social disintegration which has followed this result need not be considered here in detail. It has been detrimental to the native, and, by depleting the supply of labour, will ultimately have a serious effect on the development of the resources of the islands. Those who would pursue the subject further will find it well and impartially discussed in "Essays on the Depopulation of Melanesia,"[1] which has recently been published on behalf of the Melanesian Mission. In this instructive, and indeed valuable little book, a number of essays by missionaries, an anthropologist, and administrative officials such as Sir William Macgregor and Mr. C. M. Woodford, deal with various aspects of the question. All concur in attributing much importance to the decay of custom as a cause of the depopulation which is undoubtedly taking place in this area.

The adjustment of custom when civilised and primitive meet must inevitably give rise to difficulty. It should be the aim of the ruling power to secure this adjustment with as little harm as possible to the social organisation of the subject population. It is unnecessary to urge that certain practices cannot be tolerated under the rule of a civilised power. Human sacrifice, for example, is a case in point. It has been usual to forbid such practices entirely, as was done in the case of suttee in India. Frequently, however, total suppression entails consequences entirely unforeseen. As our knowledge of primitive peoples grows, it becomes increasingly apparent that it is difficult to interfere with one element in custom without affecting the whole. In Melanesia, head-hunting and intertribal wars have been suppressed. The results have been serious. It is not merely that these forms of activity have disappeared, but with them has gone a whole group of dependent social activities which filled the life of the Melanesian. A head-hunting expedition entailed the performance of a prolonged ritual of preparation, extending over many months, which began with the building of canoes, and included at different stages many feasts and the preparations for them. A whole group of interests, many of practical utility apart from their main object, has thus been eliminated from the lives of the natives.

The late Dr. W. H. R. Rivers, in an interesting essay which he contributed to the work mentioned above, gave it as his opinion that the most important factor contributory to the depopulation of Melanesia was psychological, and, in fact, that it was due to the lack of interest in life which followed as a consequence of the suppression of certain customs. It is interesting and significant to note, as an indication of the importance of this side of the subject, that it has led even a missionary to regret the suppression of intertribal war. It might well be worth while in such cases to endeavour, by substituting some harmless element, such as, for example, an animal instead of a human victim, to avoid total suppression of a custom embodying some objectionable features. This suggestion was put forward by Dr. Rivers; but something of the same nature is already in operation in districts in New Guinea, where the head-taking propensities of the native have been turned to account among animals which played havoc with the women's plantations.

The whole question is one of extreme difficulty and complexity. To those who realise our responsibilities to subject populations and the importance of the part the native should play in the development of tropical and subtropical lands, any suggestion of change in custom, such as that reported from Tanganyika, is big with possibilities of disaster. As a result of past experience, it is clear that each case must be dealt with on its merits and as it arises; but the general principle is equally clear that it is only by close and sympathetic study of native custom that it will be possible to avoid action which may undermine authority and destroy a social fabric upon which depends the continued existence of a primitive people.

[1] "Essays on the Depopulation of Melanesia." Edited by Dr. W. H. R. Rivers. Pp. xx+116. (Cambridge: At the University Press, 1922.) 6s. net.

Applied Electricity.

A Dictionary of Applied Physics. Edited by Sir Richard Glazebrook. Vol. II. *Electricity.* Pp. vii+1104. (London: Macmillan and Co., Ltd., 1922.) 63*s.* net.

IT is interesting to compare the second volume of Sir Richard Glazebrook's "Dictionary of Applied Physics" with the electrical portions of older dictionaries. For example, in Barlow's "Dictionary of Pure and Applied Mathematics" (1814) it is said that "the science of electricity became a general subject of conversation" after the discovery of the "Leyden Vial." In Nichol's "Cyclopædia of the Physical Sciences" (1860) we learn that electrical science "has spoken for itself to the world as no other has." "Witness the simultaneous discovery of the Leyden Phial and the Electric shock." Three practical applications of electricity are given, namely, the lightning-conductor, the electric telegraph, and electroplating. The last is specially commended as being "so conducive to the comforts and elegancies of life." An examination of the volume under review will show how greatly our knowledge has been widened during the last sixty years. We were sorry, however, not to have seen the "Leyden Jar" mentioned.

The plan of the dictionary follows to a certain extent that adopted by Nichol, but the important sections are much larger. In fact, quite substantial books could be made of the sections written by some of the contributors. Besides the important contributions there are a few short articles and many definitions of electrical quantities, machines, instruments, and methods. The absence of an index makes it difficult to find out whether any subjects have been omitted or not. There is a very elaborate name-index, but this will be little help even to the older physicist or electrician, as many of the names will be unknown to him. We think that the younger physicist will have considerable difficulty in finding out what he wants. Doubtless, this will be remedied when the final volume is published. We have not noticed anything about electric traction, electric ship-propulsion, electric vehicles, lightning-conductors, rotary and frequency converters, electrostatic machines, the attraction between electrified spheres, or the fixation of nitrogen. We take it that atmospheric electricity will come under meteorology in the next volume.

We were glad to notice that the contributors had not been handicapped by being compelled to adopt a rigid nomenclature and an invariable set of symbols. As a rule, those agreed on internationally have been adopted. Although considerable use has been made throughout of elementary vector analysis, there is little demand made on the reader's knowledge of mathematics. Academical subjects, like spherical harmonics and the perennial "electrified ellipsoid," have been omitted.

Dr. Rayner has written a useful section on alternating-current instruments and measurements. He has made a happy selection of the best modern measuring instruments. His description of the electrostatic watt-meter is specially good. Occasionally his straining after conciseness leads him into inaccuracy; as when he says (p. 11) that the torque is equal to the square of the volts instead of being merely proportional to that quantity. There is a misprint also in the equation on this page. The articles on primary batteries, accumulators, and cables are good, but the last could have been expanded with advantage. The assumption on p. 94 that the thermal emissivity is independent of the radius of the wire is certainly not true, and we doubt whether the formulæ given on p. 95 are of general application.

Mr. Albert Campbell contributes a valuable article on electrical capacity and its measurement. He generally refers to capacity as "capacitance," which is the name the Americans now use, and he calls the capacity between two conductors the "working capacity." He clearly recognises the difference between two of the various kinds of capacity and calls them by different names. In other parts of the volume, however, which capacity is meant is not so clear. For example, under units (p. 948), we read that a conductor which had a capacity of 1 farad "even though composed of plates very close together, would be very large." It looks as if conductor were a misprint for condenser. The various kinds of capacities have been clearly defined by nomenclature committees of the Physical Society and of the Institution of Electrical Engineers. On p. 107 formulæ for the capacity between two circular plates and the capacity to earth of one of them are given; the formulæ are only approximations and no limitations to their accuracy are given. Their value is therefore doubtful. We note misprints in formulæ (27), (50), (54), and (55).

T. Gray's results for the dielectric strengths (now usually called the electric strengths) of air at different thicknesses are given. We think that this is a misleading way of interpreting the experimental results. If we consider spherical electrodes in air, the disruptive voltages are computed in everyday work from their distance apart and their radii, with a maximum inaccuracy of about 1 per cent. From these experiments we would conclude that the assumption that the electric strength of air was 27·4 kilovolts per cm. at 25° C. and 76 cm. pressure, whatever the thickness of the layer might be, would lead to very approxi-

mately correct results in nearly every case. We notice that the author adopts Kennelly's names for the absolute unit of electric quantity, capacity, and pressure. We thus get the abcoulomb, the abfarad and abstatfarad, and the abvolt. As they have never been recognised, even in America, by any technical society or institution, they are "technically irregular." It has to be remembered, however, that all good new names are introduced in this way.

We do not like the phrase "dielectric constant"; it surprises, at least mathematicians, to find that this "constant" varies with temperature. Many excellent methods of measuring capacity are given, but beginners would appreciate some little guidance as to which one to adopt in special cases.

Dr. Rayner's article on dielectrics will be appreciated by engineers, and Mr. Melsom's article on direct-current indicating instruments will be most helpful in the test-room of every factory. Mr. F. E. Smith writes an authoritative article on systems of electrical measurements which will be of great value for reference by subsequent writers. Dr. Allmand gives a concise and excellent description of the technical applications of electrolysis. Any one reading the fascinating account of the electron theory and its application to spectrum analysis, by Sir William Bragg, will find it difficult to believe that Rutherford and Bohr's theories of the atom are not substantially correct. In his description of "electrons and the discharge tube" Dr. Crowther is also very convincing.

Mr. F. E. Smith gives an illuminating account of galvanometers, including very helpful rules for choosing a galvanometer for a particular purpose. Mr. Butterworth writes a valuable account of the formulæ used for measuring inductance and gives an excellent table for computing the mutual inductance between coaxial circles. We miss, however, his own formula and that of Mr. H. L. Curtis for computing the high-frequency inductance of parallel cylindrical wires. Mr. Campbell gives a very complete account of methods of measuring inductance and gives some 200 references to papers on the subject. The method of compensating for the inductance of a coil shown on p. 402 is not as accurate as the author states, a term having been left out in the algebraical reduction shown on this page. Mr. Dye, in "Magnetic Measurements and Properties of Materials," has produced a very complete account of modern methods.

The General Electric Company gives a very brief account of "incandescence" lamps, which is excellent so far as it goes. Most readers would like to have had further data on tungsten vacuum and gas-filled lamps. The Americans are not so reticent. We note that the temperature of the tungsten filament is about "2300° K." We take it that this is in the absolute Centigrade scale and that the K. refers to Kelvin. This is "technically irregular"; but there is a real demand by engineers and by some physicists that the absolute Centigrade scale, which is the one they use, be called the Kelvin scale, and we hope that this nomenclature will be adopted.

Prof. Honda gives a thoughtful article on the molecular theories of magnetism, and we have an account of Ewing's latest model. Dr. Chree writes a thorough and interesting account of the observational methods used in terrestrial magnetism, and Dr. Chapman describes some of the theories of terrestrial magnetism and how far the solar agent is responsible for magnetic storms and auroræ. Positive rays are described by Dr. Aston. A description is given of his mass-spectrograph and typical mass spectra are shown.

The lengthy article on radio-frequency measurements by Mr. Dye will be appreciated by workers in many research laboratories, as these methods are often of great value. We are doubtful whether it is legitimate to assume that the capacity of a coil can be represented by supposing that the coil has no capacity and that a condenser of a certain size is placed across its terminals. The formula for the high-frequency resistance of a round wire at an infinite distance away from other wires is given, but the formulæ found recently for more practical cases are not given.

Very complete accounts are given of switch-gear, telegraphy, and telephony, which will be appreciated by electrical engineers. We have only space to mention the valuable articles on vibration galvanometers, wireless telegraphy, and thermionic values, by Mr. Campbell, Dr. Eccles, and Prof. Fortescue. Finally, the articles by Prof. Richardson and Dr. Wilson on thermionics, Mr. Smith-Rose on the use of thermionic valves, Mr. Melsom on direct-current meters, and Dr. Crowther on X-rays, are of great value.

Under units it is stated that, at the International Electrical Conference held in Paris in 1900, the Gauss was defined to be the C.G.S. unit of magnetic force, and the Maxwell was defined as the practical unit of magnetic induction. It is also stated that if we take the permeability of air to be unity and to be a pure number, the value of the Maxwell is the same as that of the Gauss. But the Maxwell is not the unit of magnetic induction density. Hence we should read in this case that a Maxwell per square centimetre is the same as the Gauss. There are several definitions of self-inductance given: that appearing on p. 727 is wrong, as the self-inductance is the linkage of the magnetic induction, and not the magnetic force, with the current. In no case is it explained how the linkages inside the conductor have to be computed. We have

noticed a few other slips and misprints. They do not appreciably detract, however, from the value of this volume, which will be welcomed by all physicists and engineers.

Spitsbergen and its Wild Life.

Amid Snowy Wastes: Wild Life on the Spitsbergen Archipelago. By Seton Gordon. Pp. xiv+206, 2 maps and 114 illustrations. (London: Cassell and Co., Ltd., 1922.) 15*s.* net.

ALTHOUGH the Spitsbergen Archipelago is only six hundred miles from the north pole, yet, owing to its accessibility, due to the influence of the Gulf Stream drift which reaches its western shores, it has been much visited in the summer months by naturalists and sportsmen, with the result its bird-life is better known than that of a number of continental countries. Its ornithology is encrusted in a remarkable literature dating from 1598, which comprises no less than 150 contributions, and includes Prof. Koenig's "Avifauna Spitzbergensis," which from the beauty of its meisenbach pictures of scenery, and its excellent coloured plates of birds and their eggs, is entitled to rank among the most attractive of bird-books, while its letterpress exhausts the historical aspect of the subject down to the year of its publication, 1911.

The latest expedition was organised by the University of Oxford, and visited the archipelago in the summer of 1921 under the leadership of the Rev. F. C. R. Jourdain. Mr. Gordon accompanied the party in the capacity of photographer, and hence the main attractions of his book lie in the wealth and nature of its illustrations, about one hundred in number. These are supplemented by a series of pleasantly written chapters wherein he relates his personal observations and experiences. The scientific results of the expedition, however, will appear in due course; those relating to ornithology are being prepared by Mr. Jourdain, who is an eminent authority on the subject.

The most interesting pictures and chapters of Mr. Gordon's book are devoted to the pink-footed goose, Brent goose, long-tailed duck, purple sandpiper, grey phalarope, glaucous gull, and various nesting colonies. The chief captures made by the expedition were a number of eggs of the Bernicle goose, concerning the nesting habits of which no trustworthy information was forthcoming until 1907, when the first eggs were found at Spitsbergen by Prof. Koenig. Five nests and twenty eggs were obtained in 1921, but for some unexplained reason the nest of this bird—not yet depicted—does not appear in Mr. Gordon's series, though a chapter is devoted to it.

An interesting account is given of the coal-mining

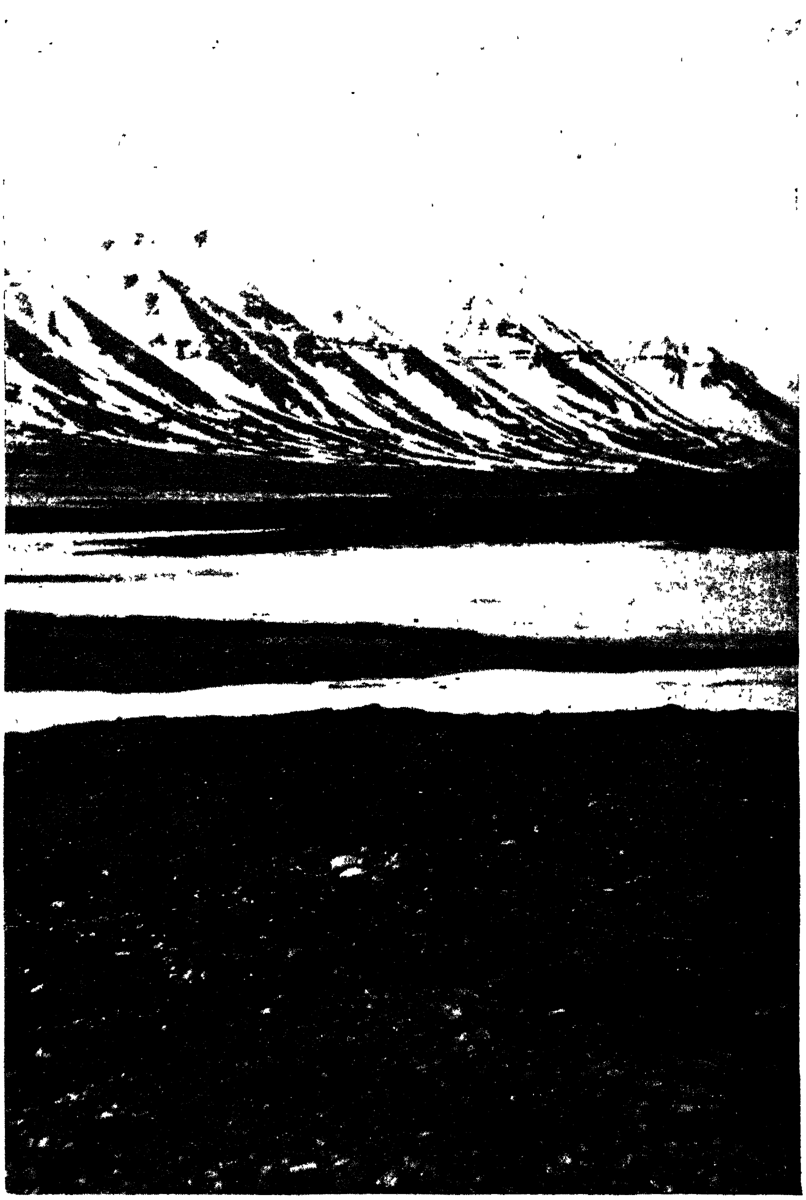

FIG. 1.—Nesting ground of the Pink-footed Goose. From "Amid Snowy Wastes."

industry, which has been developed during recent years in Spitsbergen and now finds employment for some 1300 miners, 1000 of whom, some of them with their wives and families, remain through the winter. This colonisation has effected some remarkable innovations, among others the establishment of no less than eight wireless stations whence messages may be despatched to Britain at a rate of fourpence per word!

FIG. 2.—Red-throated Diver on its nest. From "Amid Snowy Wastes."

The larger mammals, such as the Polar bear, walrus, and right whale, once extremely numerous, have long ago been exterminated, and now only stragglers appear at intervals as rare waifs. The faunal changes, however, are likely to be much more rapid in the future than in the past, since there is now a considerable human population—one that will doubtless soon be considerably increased—and Spitsbergen being a no-man's-land, no protection can be imposed, and its animal life will suffer accordingly. There are three characteristic animals in the archipelago which are likely to become extinct, namely, the reindeer (*Rangifer platyrhynchus*), which is endemic, the fox (*Canis spitzbergensis*), and the ptarmigan (*Lagopus hyperboreus*). The deer, once very numerous and still unsophisticated, has been ruthlessly slaughtered in recent years. The fox since the advent of the Norwegian hunter, with his traps and poison, has been almost exterminated in places where it once occurred in hundreds. There is only one species of fox in Spitsbergen, the two species alluded to by Mr. Gordon being colour-phases due to season or age.

FIG. 3.—Purple Sandpiper on its nest. From "Amid Snowy Wastes."

Special efforts were made by the expedition to find the ptarmigan, the only resident land bird, but without success, though all their likely haunts were visited, including a valley where Mr. Gordon tells us in 1920 no less than fifty brace were shot in a single afternoon by members of the Scottish Spitsbergen Syndicate. These birds must afford poor sport, for Dr. van Oordt tells us they are so tame that they can easily be killed with stones.

The eider is another bird that is rigorously and systematically persecuted. Enormous numbers of its eggs are annually taken for food and down is collected from their nests—both for sale in Norway. Mr. Gordon relates that one sloop, which had already 15,000 eggs on board, was still engaged in adding hundreds of eggs daily to the hoard. It is to be hoped that the rarer and more interesting species alluded to are also natives of the eastern isles of the Archipelago, which are so beset with ice that they are little known, and that thus they may escape extinction.

W. E. C.

The Reopening of Europe.

Frequented Ways: A General Survey of the Land Forms, Climates, and Vegetation of Western Europe, considered in their Relation to the Life of Man; including a Detailed Study of some Typical Regions. By Dr. Marion I. Newbigin. Pp. xi+321. (London: Constable and Co., Ltd., 1922.) 15s. net.

A LARGE part of Europe is again open to the traveller. Dr. Newbigin, president of the Geographical Section of the British Association this year, does well to direct attention to the frequented ways, and her book asks those who follow them to adopt an appreciative outlook, casting off the insularity bred among our western isles. Insight into the relations of nature and man in Switzerland is not to be gained by selecting hotels where an English chaplain is on the staff. Dr. Newbigin has evidently suffered in this matter, and she remarks (p. 165) that the Catholic religion has the advantage "that no particular form of dress is imposed upon the worshippers." Her appreciation of the unconventional might have made her more tolerant (pp. 1 and 163) of "the superior person" who has been driven from anglicised Grindelwald to Japan or the New Zealand Alps. If she thinks that these fields are reserved for the prattling millionaire, let her consider Mr. Ralph Stock's exquisite little book on the voyage of "The Dream Ship" (1922), and see how the spirit of the Elizabethans may still carry our island-folk, both male and female, across the viewless seas.

Dr. Newbigin rather overlooks the value of a continuous traverse of a land-surface by the pedestrian, the cyclist, and the new users of highways that have not been so frequented since my lord and my lady took their own carriage into France. Automobilists are not always mere diffusers of dust and lubrication-odours; thousands are ready to respond to a training in history and geography. Dr. Newbigin conducts us inevitably by railway, and it may be noted that her information as to lines in the Eastern Alps is not entirely up-to-date. If, moreover, she prefers Basel, with good reason, as a place-name, why does she write Berne, St. Gothard, and the purely English Botzen, which should now, we presume, become Bolzano? She goes so far as to discuss (pp. 37 and 42) the merits of various tunnels through the mountains; these, after all, are the frequented ways. The *Gazette of the Cyclists' Touring Club* for August 1922 will show her, however, that even the Arlberg road is not forsaken. Again, in her essay on the Scottish Highlands, we should like to hear more of the pedestrian who travels across the glens as well as down them, in his attempt to realise their "relation to the life of man."

The author seems carried away at times by a certain vigour of self-expression, as if she had been caught in the swirls of "the revolt against civilisation." On p. 48 she writes, "latitude is only one of the factors which influence climate," and styles this "current geographical slang." Three pages on, she tilts against "latent heat," surely a very innocent antagonist. Again, has geographic environment moulded "the ferocious individualism of the Scot" (p. 261), which causes him to charge as much as 2s. 6d. for a belated breakfast on a winter's day? Is not this seeming lack of hospitality to be ascribed to the advent of tourists from the south, by way of Edinburgh, into the quiet of his ancestral wilds? Do we not remember how a cotter's wife was on the look-out for us one morning with a gift of oatcake, lest we should go hungry on a twenty-mile track under the Paps of Jura; or how a poor fisherman forced a tepid meal upon us, with the remark, "I should not like you to pass this house"? This is how the loneliness of moor and island have really affected the Gael of the old stock, despite the clan-animosities intensified by seclusion in the glens. Dr. Newbigin is at her best, and thus at a high level, in dealing with the influence of climate and land-forms on European vegetation. Had our military organisers known as much geography as is compressed into p. 55, the "mediterranean climate" would not have wrecked a band of gallant men sent up into the snows from Salonika.

Dr. Newbigin's photographs are a change from too familiar scenes. She gives us, for example, the vine-clad pergolas of Domo d' Ossola and the deforested slopes above La Grave. She certainly did not reach the latter spot by railway. In the Italian chapters, while seeking to be moderate, she cannot conceal a genuine hate of Venice; and, when she justly charms us with Ravenna, she elaborates a contrast that cannot be entirely sustained. Did the Goths consciously embrace the creed of Ulfilas because his homoiian views provided a religion for "free men"? We are puzzled by the intricacies of p. 292, and are not going to allow so good a geographer to entrap us in the maze of Alexandrian controversy, or into a discussion of the Virgin enthroned with angels in Sant' Apollinare of Ravenna. It is more profitable to note that the explanation given (p. 231) of phenomena at the Solfatara confirms a suggestion recently made in NATURE (vol. 109, p. 559).

Dr. Newbigin's reliance on the railways leads her to call (p. 309) the Assisi–Foligno–Orte loop "an easy route" to Rome. The alluvial infilling seems to have made her forget that she is running upstream past Monte Subasio, and that clever engineering was required to get back from Spoleto by the gorge of

Narni to the Tiber. Bertarelli's "Guida itineraria del Touring Club italiano," route 180, puts the true aspect of this dissected country before the geographic tourist. Such tourists will receive much encouragement from the broad views of western lands provided in the book before us. Perhaps in another volume the author will show how intensive studies of equal value may be carried on by easy deviations from frequented ways. The piazza of Todi, 1350 feet above the sea, Foix on the Ariège, guarding one of the few passes into Spain, or Radstadt, tinkling with cattle-bells, on the high pastures of the Tauern, may serve as epitomes of their regions and of the reaction of environment on man. But Dr. Newbigin certainly does not need suggestions.

GRENVILLE A. J. COLE.

History of Astronomy.

Histoire de l'Astronomie. Par E. Doublet. (Encyclopédie scientifique.) Pp. 572. (Paris: G. Doin, 1922.) 17 francs.

IN his first chapter the author passes in review the principal works on the history of astronomy, beginning with Weidler's book and ending with the great work by Duhem on the cosmical systems. Of the valuable books of Grant and R. Wolf, only the titles are given, and several others are omitted altogether. Of monographs, only Schiaparelli's first two papers are mentioned. This is natural enough, since there is plenty of evidence that the author is quite unacquainted with the rich literature of memoirs and short papers on the history of astronomy which has appeared within the last fifty years. Whenever a fact is not mentioned by Delambre, Duhem, etc., it will be looked for in vain in M. Doublet's pages, and whenever fresh light has been thrown on any subject since they wrote, he is not aware of it. Take, for example, the paragraph on Hipparchus. We are told that his diopter was in the Middle Ages called a Jacob's staff; in reality the former had a cursor with a round hole in it, and was used only for measuring small angles such as the diameters of sun or moon, while the latter was shaped like a cross, with the shorter arm movable (on p. 152 the invention of the baculus is correctly attributed to Levi ben Gerson of Avignon, as Duhem had also done). The star of Hipparchus is compared to the new star of 1572, whereas there can be no doubt that it was nothing but the comet of 134 B.C. The star-catalogue of Hipparchus is said to contain 1025 stars and to have been handed down to us by Ptolemy, but it has been shown by Boll that the catalogue probably contained only about 850 stars, while it is now universally recognised that Ptolemy's catalogue is not a mere reproduction of that of Hipparchus. Next it is stated that Hipparchus put the solar parallax equal to 3'; it was Ptolemy who did that, whereas Hipparchus said that it was at most a minute and a half. On the same page we read that Hipparchus determined the principal lunar inequalities with admirable precision. Hipparchus knew only one inequality, the equation of the centre; but that is, perhaps, a slip, as it is elsewhere (p. 110) mentioned that Ptolemy discovered the evection.

The most valuable part of Duhem's work is his account of Latin astronomy in the later Middle Ages, as he was able to make use of many manuscript sources. M. Doublet has done right in quoting him largely; but here, as everywhere else, the consequences of never referring to the original sources are evident. Duhem gives a very unsatisfactory account of the planetary system of Al Betrugi, which was very much discussed in the thirteenth century both at Paris and at Oxford. The account of it by M. Doublet similarly misses the most important part of the system. In the same way, the account of King Alfonso and his Tables reproduces all the old misstatements which have been refuted long ago. The tables were *not* published at the time of the King's accession, but some twenty years later, and *no* change was made in them as regards precession; they were *not* prepared by a "numerous commission," for it would have been necessary to raise the dead, since the alleged members of that Royal Commission lived long before King Alfonso's time. The "Libros del Saber" were never translated into Latin, and were quite unknown until they were at last printed some sixty years ago, and the last edition of the tables was not printed then, but in 1641.

The author's account of the progress of astronomy from the end of the Middle Ages to the time of Newton does not differ much in extent or quality from the earlier chapters. We have only space to direct attention to a misunderstanding on p. 255, with regard to Kepler's work on Mars. What produced errors of 8' was not the use of the Tychonic system (for that, of course, made no difference whatever, being merely the Copernican system with the origin of co-ordinates transferred to the earth), but the use of an excentric circle with "bisected excentricity," after the manner of Ptolemy.

Having found the first two-thirds of the book rather disappointing, we are glad to say that the chapters on French astronomers in the eighteenth and first half of the nineteenth century are very interesting and pleasant to read. They do not go into details as to the work of these astronomers, any more than do the earlier chapters, but they tell a good deal about the Cassinis, the Maraldis, etc., down to Arago and Leverrier, which will be new to most readers.

J. L. E. D.

Our Bookshelf.

How to Measure in Education. By Prof. W. A. McCall. Pp. xiii+416. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1922.) 15s. net.

IN the work under notice an attempt is made to show that everything in education must submit to statistical measurement or be condemned as worthless. Fourteen theses in praise of measurement are blazoned in large type at the outset. One of them states, "To the extent that any goal of education is intangible it is worthless"; as this is given not only the dignity of capitals but also the embellishment of inverted commas it presumably conveys some meaning to the author. Education in this book means a few of the elements of instruction, such as reading, writing, and the mechanical parts of arithmetic and composition. An elaborate analysis is given of how to diagnose defects in reading, and ignoring the analysis, we are told that "there are more failures due to failure of interest than the world dreams of." The schoolmaster who has important tasks in education other than those of teaching mechanical elements would greatly value some help in measuring the interest of his pupils, but will ask in vain. The importance of carefully framed instructions in giving tests is rightly stressed, but we are told that such "instructions should equalize interest." To accomplish this the pupil must, apparently, be told how important it is to do well in a test. If he is refractory, or keen on other things in school besides tests, the advice may not be effective. Masters, however, are in a worse plight, for the tests are used not only to measure the pupils, but also the teaching and the teachers; and that form of measurement is said to be of most service "which does not require a previous acquaintance with the pupils."

The most valuable part of the book is that concerned with "scaling the test," as it shows the large amount of statistical treatment necessary to prepare a suitable test of skill. A useful suggestion is made for fixing a single common unit of measurement for all mental scales for elementary schools, namely, some function of the variability of pupils of twelve years. The standard deviation of pupils of sixteen years is also suggested as a unit for measuring older scholars.

The final section of the book deals with tabular, graphic, and statistical devices. Each part has a useful students' bibliography, but it is strange to note the omission, in a work of this nature, of all reference to the writings of Udny Yule, from whom the student of statistical methods will derive more real help than from any of the authors quoted.

Fruit Farming: Practical and Scientific for Commercial Fruit Growers and Others. By C. H. Hooper. Second edition, Revised and Extended. Pp. xxiii+212. (London: The Lockwood Press, 1921.) 6s. net.

WITHIN the limits of two hundred pages Mr. Hooper has aimed at the production of a text-book of fruit farming under English conditions. After a brief introductory section on the training of the prospective grower, he deals in succession with the capital required, the selection of suitable land, the law in relation to fruit farms and market gardens, the laying-out of plantations and orchards, and the cultural details and costings of the more important hardy fruits of this country. The later chapters are concerned largely with the more scientific aspects of the subject, such matters as soils, manuring, insect and fungoid pests, and spraying and other forms of disease-control in turn receiving attention. Also included are brief histories of many of the well-known varieties of apples, pears, plums, and cherries. The numerous interesting and economically important problems relating to pollination and fertilisation and the setting of fruit are briefly considered and the author is able here to provide data from his own investigations. The volume is completed by several sections dealing with special points of a purely commercial character, as, for example, the marketing of fruit and book-keeping.

Many chapters have been contributed by specialists and present in an abbreviated form the results of recent research. A large part of the volume has in fact been re-written since the first edition and brought up-to-date. With these alterations and some useful additions the second edition justifies its appearance.

In a work of so small a compass, which seeks to stand as a text-book of its subject, the selection of matter for inclusion calls for careful discrimination. It is open to some criticism in this respect and also for occasional repetition. Printers' errors are not infrequent in certain chapters. Much of the information given on economic points is not readily accessible elsewhere, and it is in this direction probably that the volume will prove to be of most service to its readers.

First Lessons in Practical Biology. By E. W. Shann. Pp. xv+256. (London: G. Bell and Sons, Ltd., 1922.) 5s.

MR. SHANN'S endeavour to provide a course of biology suitable for lower fifth forms, and within the means of the average school, is not entirely satisfying. Rightly he relies on plants for the experimental work, and on both plants and animals, employing them in alternate chapters, for the observational. But experiments on plant physiology are not reached until chapters 16 and 17; and by that time the preceding lessons have incidentally given the very information which the experiments should surely be intended to enable the pupils to discover for themselves. There are good chapters on variation and heredity, soils, insect pests, and other topics of general biological interest; but neither with plants nor with animals does the author make the best use of his material as a means of education and of training the powers of observation and reasoning. If he disapproves of the heuristic method, he should at any rate indicate the evidence on which conclusions as to homologies are based, and not be content with mere statements.

Apart from general considerations, sentences are in several instances faultily composed; and there is a large number of actual errors: *e.g.* "false" fruits are wrongly defined; rose-hips *will* germinate without passing through the digestive tract of an animal; rose stamens are peri-, and not epigynous; *Urtica urens* has *not* a creeping stem; the biramous appendage is *not* the primitive form of crustacean appendage; the telson is *not* a segment; the abdomen of Blowfly does *not* exhibit respiratory movements; the embryo in a

seed is not simply the plumule and radicle, but includes also the cotyledons—we have not exhausted the list of inaccuracies.

Many of the illustrations are the work of boys at Oundle School and are of creditable draughtsmanship; but for teaching purposes we prefer outline with a minimum of shading in order that significant features may receive due emphasis.

The Discovery of the Circulation of the Blood. By Dr. Charles Singer. (Classics of Scientific Method.) Pp. x+80. (London: G. Bell and Sons, Ltd., 1922.) 1*s.* 6*d.* net.

THIS is the first of a new series entitled "Classics of Scientific Method," and whets our appetite for its successors. The series aims at providing in convenient form reproductions of the great masterpieces of science, together with an account of the action and re-action of ideas which, through process of time, led up to the crucial experiments carried out and described by some great master. This account of Harvey's discovery of the circulation of the blood is excellent. The first chapter, in language freed so far as is possible of technical terms, describes the structure and function of the circulatory system as we now know it—a modification of the paragraph on p. 8 dealing with the relation of carbon dioxide and hæmoglobin seems desirable—and contains a clear diagram. The subsequent chapters set forth in words and by illustrations the ideas held by the ancients regarding the vascular system, and how the Renaissance of the fifteenth century and the work of such men as Leonardo da Vinci, Servetus, and others, culminated in Harvey's great discovery, of which a detailed and most interesting account is given.

Laboratory Exercises in Inorganic Chemistry. By Prof. J. F. Norris and Prof. K. L. Mark. (International Chemical Series.) Pp. x+548 (every second page blank). (London: McGraw-Hill Publishing Co., Ltd., 1922.) 10*s.* net.

THE first question which must be considered in connexion with a book of this kind is the class of students for whom it is intended. The preface indicates that it contains a first year's course for students who have had "a good training in chemistry in the high school." It is unsuitable for such students in England, as many of the experiments would already have been done at school, and many of the remainder would be regarded as too difficult for Intermediate students. The "International" character of the book is therefore open to question. Although the book is not suitable as a students' manual in English colleges, it should be very useful in suggesting experiments to teachers, both for lectures and for laboratory work. Many of the directions are given in unnecessary detail for students of average intelligence: how to light a Bunsen burner, for example, and there is a good deal of repetition. The blank pages are included in the pagination.

A Text-book of Organic Chemistry. By Dr. A. Bernthsen. New edition, revised to date, by Prof. J. J. Sudborough. Pp. xvi+908. (London and Glasgow: Blackie and Son, Ltd., 1922.) 12*s.* 6*d.* net.

BERNTHSEN'S text-book, in its English translation, has proved of great value to students. It is therefore satisfactory to note that the new English edition has been carefully revised and large sections dealing with important recent advances in the science added, as well as numerous small supplementary paragraphs in the old text. For a book of this character the minor errors noted are surprisingly few, and are obvious to the reader. One important omission may be noted: on p. 78 it is stated that methyl alcohol "acts as an intoxicant like ethyl alcohol," without a word as to the very deleterious physiological action of methyl alcohol. The printing and get-up are excellent, but the binding is too weak for students' use. The moderate price of the book, as well as the clear and accurate character of its contents, will ensure its continued popularity among students. The very full references to physical properties make it also a handy book of reference in the laboratory.

Plumbers' Handbook. By Samuel Edward Dibble. Pp. ix+629. (New York and London: McGraw-Hill Book Co., Inc., 1922.) 20*s.*

THE author of this handbook has had the co-operation of several well-known American professional men, and the result is a very valuable compendium relating to plumbing, sanitary arrangements, gas-fitting, heating, etc. The book is equally suitable for the practical man engaged in carrying out schemes, and the student who is learning his business. Of special interest to the British reader is Section 14, dealing with codes, or byelaws, as we should call them. These are extremely suggestive, and if carried out systematically in the United States will excite the envy of many British workers who have still to endure primitive sanitary conveniences. There is so much of value in this section that it is impossible to quote any of the points in a short review.

Science is not neglected in this volume, and there are sections dealing with metallurgy and chemistry. There is also a section on elementary mathematics; we think that the arithmetical rule for cube root (p. 511) might have been omitted, especially as logarithms are dealt with on pp. 508 and 509. The book can be strongly recommended to all connected with sanitation.

Diptera Danica: Genera and Species of Flies hitherto found in Denmark. By William Lundbeck. Part VI. *Pipunculidæ and Phoridæ.* Pp. 447+137 text-figs. and index. (Copenhagen: G. E. C. Gad; London: Wheldon and Wesley, Ltd., 1922.)

ALL students of the order Diptera will welcome the continuance of this wholly admirable treatise. It is a model of what a faunistic work should be and, unlike so many volumes of a similar nature, it also includes a useful summary of existing knowledge of the metamorphoses and habits of the insects with which it deals. The author has also wisely added the dates of capture of the various species: elementary facts of this kind are so often omitted from faunistic works that the reader is usually left with no idea as to when a particular species is likely to be met with. Of the two families dealt with in the volume before us, the Pipunculidæ include 25 Danish species out of about 75 palæarctic representatives, and the Phoridæ include 210 Danish species out of a total of about 335 from the whole of Europe. The work is well printed, clearly illustrated, and written in excellent English.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Action of Cutting Tools.

PROF. F. G. COKER has been good enough to send me a copy of his paper on the above subject, together with the discussion which followed its reading before the Institution of Mechanical Engineers. I will (with your permission) take this opportunity of thanking him and of adding a few remarks to my letter to NATURE of August 26 of this year.

I had not, when that letter was written, a copy of the Proc. R.S. paper of 1881 at hand, and was not certain as to how far the experimental processes preceding its production were described. On re-reading, however, I see that the experimental part was omitted, and I may here state that the force on the tool was measured by a dynamometer of the type shown diagrammatically in Fig. 1, and that it was found that for cuts of similar section the force required was very nearly proportional to the cross-section of the strip removed. This of course is equivalent to the statement that the same amount of work will remove the same volume of material whether the shavings are thick or thin, provided that they are similar.

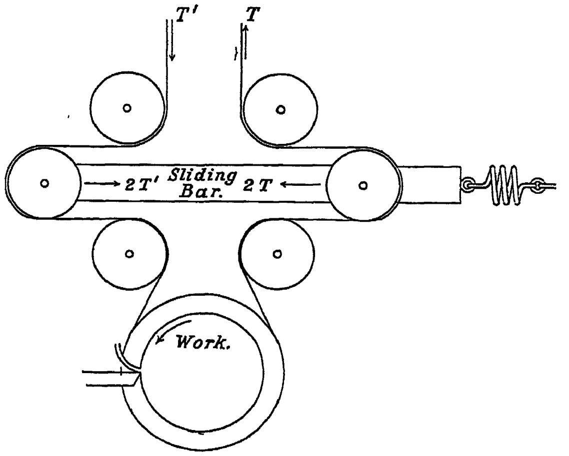

FIG. 1.—Diagrammatic sketch to show the action of dynamometer used for measuring the force on tool, T and T' being the tensions of the two parts of the driving belt. The force acting on the sliding bar is 2(T - T'). This is balanced by the extension of the spring. Hence the movement of the bar, in conjunction with the known diameter of the work, gives (when corrected for the friction of the pulley, etc.) a measure of the force acting on the tool.

This dynamometer, which recorded the force automatically on paper moving with a velocity proportional to that of the cut, worked satisfactorily when the cutting speed was suitably chosen, though I should not use the same pattern were I again to embark on such investigations.

The materials on which the experiments were made included, besides the ordinary metals, others easier to deal with in a lathe worked by foot, and of these clay was found to be the most useful, for, according to the state of dryness to which it was brought, its behaviour under the action of the tool could be made to resemble that of any sort of metal, hard or soft, and at the same time cuts of easily measurable thickness could be taken with comparatively small forces.

While referring to the subject of material, I may mention a matter which seemed to me rather surprising. I wished to see whether it would be possible to face up a speculum casting in the lathe in order to save time in the preliminary grinding. Speculum metal, as is well known, is very brittle, but by taking a broad cut of extreme thinness with a dead-hard steel tool, continuous shavings were produced which looked like ribbons of grey satin. It was only while the edge of the tool was perfect that the cut was satisfactory, and this condition rarely lasted long enough to cover a speculum two inches in diameter.

With regard to Prof. Coker's paper, the only objection I have to make is that it has no reference to the action of cutting tools. The polarised-interference bands are evidence of elastic strain. They might be maintained indefinitely when the tool was stationary if the applied force was just insufficient to produce further rupture, and would disappear when that force was removed.

The elastic deformation, though interesting, has nothing to do with the special action of the tool, the essential function of which is to cause destructive strain throughout a small region near its edge while having no permanent effect on the body of the work.

The real interest in the action of a cutting tool is confined to the plane AB (Fig. 2) along which destructive shear takes place and a very short length of the material which forms the shaving—together with that part of the tool in contact with it.

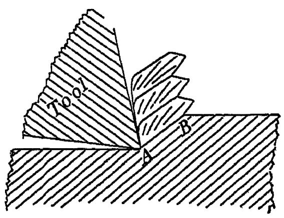

FIG. 2.—Action of a cutting tool, showing the principal and secondary planes of cleavage.

The internal structure of a shaving closely resembles that of slate, the principal plane of cleavage being parallel to AB of Fig. 2, and the angle which this plane makes with the direction of the cut is modified by, and may be said to depend on, the angle which the face of the tool makes with the same direction and the mutual coefficient of friction between the tool and the material on which it operates.

The action of the tool is always discontinuous and quasi-periodic, the period being determined by the travel required to extend the destructive shear from A to B. The period, therefore, is proportional (among other things) to the depth of the cut.

From this it may be seen that, in addition to the principal planes of cleavage, secondary and slightly differently inclined cleavages occur before the shearing across AB is complete. This was well shown in the polished and etched sections [1] referred to in the 1881 paper, and can also be recognised in the accompanying photographs (Figs. 3 and 4), though not quite so clearly.

The normal force on the tool during each period tends to expand (like rivet heads) the base of the strata which press against it, and this action causes the shaving to curl: the frictional force (parallel to the face of the tool) tends, on the other hand, to drag the base of strata towards the cutting edge, and thus to keep the shaving straight.

The shape of the cross-sections of a shaving is often rather peculiar, but is a definite function of the shape of the tool and of the properties of the material from

[1] The earliest application of "etching" for the purpose of rendering the structure of a metal visible was, I suppose, the "crowning" of twisted gun-barrels, etc.

which it is cut. It may be defined shortly as the projection on the plane of the section of the line bounding the area of destructive shear. This line will be in advance of the face of the tool by a distance

FIG. 3.

FIG. 4.

FIG. 3.—Shaving from a block of paraffin. At the temperature at which the cut took place, the paraffin behaves much like a sample of cast iron.

FIG. 4.—Longitudinal section of a similar shaving. The paraffin shaving was embedded in soap, sectioned in a microtome, and mounted in castor oil.

proportional to the thickness of the cut at the point under consideration (see Fig. 5).

The shaving is always shorter than the length of the cut from which it was taken, and if α and β are respectively the angles which the principal plane of cleavage and the face of the tool make with the normal to the surface of the cut, it is easy to see that the ratio of the lengths is $\cos\alpha/\sin(\alpha+\beta)$.

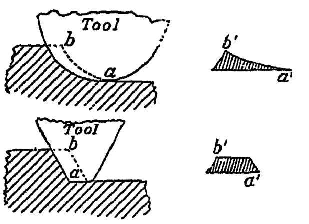

FIG. 5.—Relation between the cross-section of the cut, *ab*, and that of the shaving produced, *a'b'*.

Lubrication has an extraordinary effect in the cutting of certain materials. With brass and gun-metals no lubrication is required, but for steel, and also for such metals as soft copper and pure aluminium, clean cutting is impossible without it. Glass cutting with steel tools also requires a lubricant, for which purpose turpentine or petroleum are generally chosen.

I remember, in a correspondence with Sir G. G. Stokes on this subject, mentioning that even the presence of turpentine vapour had a noticeable effect. There can, I think, be little doubt that films of lubricant (of molecular thickness it may be) pass not only over the active part of the tool, but also penetrate along the planes of cleavage in the shaving itself.

A. MALLOCK.

9 Baring Crescent, Exeter.

One Possible Cause for Atmospheric Electric Phenomena: A Reply.

IF Sir Oliver Lodge will turn up his copy of NATURE for January 21, 1904 (Vol. 69, p. 270), he will find that I made there the identical suggestion for the origin of the earth's negative charge which he makes in NATURE of October 14, p. 512. The explanation is, however, unsatisfactory for a number of reasons, the chief of which may be stated shortly as follows:

To maintain the current from the earth into the atmosphere, it would be necessary for 2000 negative electrons to be shot into each square centimetre of the earth's surface every second. But beta rays ionise the air through which they pass, and according to recent theoretical work it appears that beta rays, no matter what their velocity may be, produce more than 40 pairs of ions along each centimetre of their path in air at atmospheric pressure. Thus in each cubic centimetre of air near the earth's surface 80,000 pairs of ions would be produced per second. But we know from actual measurements extending from the equator to the polar regions that only 4 or 5 are so produced and all these can be accounted for by known radiations.

Sir Oliver suggests that "the beta particles would be magnetically inveigled towards the poles, where they might descend with down currents." This suggestion has been made previously, and it is easy to show that it offers no way out of the difficulty although the demonstration is too long to be given here.

G. C. SIMPSON.

October 17.

The Green Ray at Sunset and Sunrise.

IN NATURE of October 14, p. 513, Prof. Alfred Porter maintains that there are two distinct phenomena which go under the name of the green flash, and that the one most usually seen is an after image in an eye fatigued by the red light of the sun. I have seen the green ray many times in this country and in the tropics, and the phenomenon as I have seen it is always exactly the same; I am quite convinced in my own mind that it is not due to eye fatigue, for the appearance at sunrise is precisely the same as that at sunset; I have seen it a number of times at sunrise, and the first time I ever saw it was at sunrise when I was not looking out for it. I have, moreover, examined the setting sun with binoculars and with a telescope; when the sun has very nearly set, but before the appearance of the green ray proper, the upper edge has a very irregular shape owing to refraction effects, sometimes resembling flames; the tops of the "flames" gradually become bright green and the colour spreads downwards till the whole of the minute remaining part of the disc becomes green. To any one who has examined the green ray with a telescope at sunset, and has seen it with the naked eye at sunrise, it seems inconceivable that it can be due to eye fatigue.

C. J. P. CAVE.

Stoner Hill, Petersfield,
October 21.

As the green segment continues to be debated, permit me to put a few facts on record. I have often in Egypt watched the sunrise light descending the western hills, and when the edge of the shadow reached me, turned to view the sun. The first appearance of the sun is a blue segment, changing to green, and then to white. This is exactly the converse of the colours of the sunset segment; as the rising light cannot be due to an after-image, no more is the setting light. Moreover I have never seen the green light shift about, as an after-image does, by movement of the eye; it is always exactly on the segment.

Further, I often have protracted the sunset blue by walking up a slope, and so keeping it in view, on and off, as long as I go upward. The least distance

of horizon that is effective is about two miles, at which the change of colour is just visible. The "second phenomenon" of Prof. Porter is the only one which I have seen with open eyes.

W. M. FLINDERS PETRIE.

A Broadcast "Rainbow."

ON Friday, September 16, I witnessed an atmospheric phenomenon sufficiently unusual, I believe, to merit a record. Standing on Ogmore Down near Bridgend in this county (Glamorgan) at 2.30 P.M. and looking northwards across the broad vale towards the Maesteg hills, there appeared to me a broadcast rainbow colouring, stretching east and west for several miles along the vale. The day was exceptionally fine, with brilliant visibility and no trace of mist. The clouds were small and scattered, with a distant bank of cumulus beyond the hills, while the colours were clear and unmistakable, covering, from red in the west to blue in the east, an angle of about fifty degrees. The height of my point of view was about 300 ft. above the sea, and the whole apparition hung, like a veil of pure, immaterial colour, at about the level of my eyes, covering the distant hills but without screening their smallest particular. R. C. MCLEAN.

The Botanical Department,
University College,
Cardiff, September 19.

Colour Observations of the Moon.

I WISH to place on record a few observations I have made of the lunar surface seen through colour filters, which point to the presence of coloured light of various shades reflected from different parts of the moon.

The light values of various points of the moon's surface were fixed by means of a photometer shaded by colour-screens, corresponding to similar screens fixed to the eye-piece of the telescope.

Owing to the two different sources of light, electric light in one case and the lunar rays in the other, and also owing to atmospheric changes, the two sets of filters had to vary considerably in colour, in order to produce the identical colour impression on the eye.

For the telescopic eye-piece I used the following colour screens throughout these observations:

1. Red of approx. 6563 "Tenth-metre" wave-length (absorbing practically all but red rays and a little yellow).
2. Green " 5173 wave-length (absorbing all but green and blue rays).
3. Violet " 4420 wave-length (only absorbing yellow rays).

For the photometer I used varying colours (according to atmospheric conditions), averaging

1*a* of approx. 6120 wave-length.
2*a* " 4922 "
3*a* " 4550 "

The area examined was the vicinity of Clavius. I determined the light value of the brightest spot in the neighbourhood (A) through the three screens, and in the same way a number of other spots; B, the eastern inside wall of Clavius; C and D, the floor of the crater plain; E, the great valley to the west of Clavius; F, the southern slopes of Maginus.

The result of the two observations, No. I. on August 31, No. II. on October 1, 1922, was as follows, reducing the figures to percentages, the brightest spot (A) being taken as 100 per cent. in each case:

	A.	B.	C.	D.	E.	F.	
Red screen	100%	I. 46·0 II. 9·1	I. 1·2 II. 0·66	I. 3·6 II. 0·85	I. 10·0 II. 2·2	I. 15·7 II. 9·1	% %
Green screen	100%	I. 4·2 II. 22·2	I. 0·7 II. 0·3	I. 1·3 II. 0·46	I. 14·0 II. 2·5	I. 49·0 II. 22·2	% %
Violet screen	100%	I. 30·0 II. 5·4	I. 3·3 II. 1·7	I. 8·4 II. 2·0	I. 15·0 II. 2·8	I. 21·4 II. 5·4	% %

In examining the above list it will be noticed that there is a discrepancy regarding the point B, which may be due to the dazzling brilliancy of this area during the first observation. All the remaining figures, however, agree remarkably well, considering the extreme simplicity of the instruments I employed.

The experiments tend to show that (1) the floor of Clavius (also of Longomontanus, which I observed on October 1) is of a mauve colour. These areas may be basaltic and not unlike some Hawaiian crater plains of solid lavas. (2) The Terra Photographica to the west of Clavius has most probably a mottled surface of brown areas on a blue background such as copper sulphate. (3) The southern slopes of Maginus are intense green, probably streaked with areas of the same substance and colour of the crater valleys recorded.

It would be of great interest to survey accurately in this manner districts such as the crater Linné. Later tests would then clearly show if any change could be recorded in these debated areas, at least so far as coloration is concerned. A. F. WARTH.

109 Sandford Road,
Moseley, Birmingham.

The Local Handbook of the British Association.

IN NATURE of October 21, p. 539, a reviewer states that "the ideal handbook in connexion with the annual visits of the British Association has yet to be written." A Committee of the Association might well be appointed to draw up a scheme. Meanwhile, I venture to offer the following suggestions:

1. The book should above all be portable, and for this purpose it should be divided into separate pamphlets, each tucked under a separate tape in a cloth-covered binding, common to the series. One could then select one's pamphlet and leave the rest in one's hotel.
2. Every handbook should have a complete index for facilitating rapid consultation.
3. There should be a map of the district on the half-inch or quarter-inch scale.
4. There should be a geological map.
5. The compilers should take a lesson from Baedeker and give practical details: population, railway stations, hotels, cab-fares, post office; short list of the chief features—museums, art galleries, libraries, churches of architectural interest, and other guide-book information—in two or three pages, with street in which situated, times of opening, etc., with an asterisk indicating the most noteworthy.
6. Unless the handbook can be sent by post in advance to members (they might pay the postage) it is of little use writing long-winded articles, as visitors—attending sections in the morning, scientific excursions in the afternoon, and addresses in the evening—have no time to read them. BERNARD HOBSON.

Thornton, Hallamgate Road, Sheffield,
October 20.

The Early History of the Land Flora.[1]

By Dr. D. H. SCOTT, F.R.S.

I.

IN these articles the "Early History" of the land flora is understood to cover the Devonian and Lower Carboniferous periods. Before the beginning of the Devonian the records of land plants are too scanty and doubtful to demand much consideration; on the other hand, the flora of the Upper Carboniferous is so rich and so well known that to include it would unduly extend the limits of this brief survey.

Concerning the question of the beginnings of a land flora, the position has wholly changed of late, owing chiefly to the Rhynie discoveries. A few years ago we had no clear knowledge of any early Devonian plants, and such imperfect data as we posesssed were commonly ignored or discredited. Nothing definite was known of any really simple fossil land-plants; it could even be asserted that the Devonian plants, though different in many ways from those of the present day, were about on the same general level of organisation.

Now we have learnt, from the Rhynie investigations, that, in the earlier Devonian flora, plants existed of quite surprising simplicity, with a mere thallus, leafless and rootless, like that of some very ordinary seaweed, but yet vascular in structure, and obviously adapted to sub-aerial conditions.

The crude simplicity of some of the Rhynie plants even suggested the question whether we might not at last be on the track of the original transmigrants from the sea, of those Thalassiophyta whose conquest of the land has been so vividly pictured by Dr. Church.[2] No doubt, the Devonian period was altogether too late for the transmigration he describes, but still some of the plants then living might have retained transmigrant characters.

The Rhynie fossils are now fairly well known to the botanical reader, and it is perhaps less necessary to insist on their importance than to suggest a warning that we may possibly expect too much from them.

The flora is extremely limited and local; our knowledge of the plants, owing to the unsurpassed skill and judgment with which they have been worked out by Dr. Kidston and Prof. Lang,[3] is exceptionally perfect, but there are very few of them and they are all from one old peat-bed.

We may shortly recapitulate the leading facts. The Rhynie species of vascular plants are four in number: *Rhynia Gwynne-Vaughani*, *R. major*, *Hornea Lignieri*, and *Asteroxylon Mackiei*. Rhynia and Hornea constitute the family Rhyniaceæ, remarkable for its extreme simplicity of structure; Asteroxylon is a much higher plant, and is placed in a distinct family.

Both the Rhynias are rootless and leafless plants, with a branched underground rhizome, and a vertical aerial-stem, also branched; the whole plant was eight inches or more in height. On the rhizome there are absorbent hairs, while the aerial stem possesses a few perfectly typical stomata. Otherwise there is little differentiation between the subterranean and sub-aerial parts. The whole may be called, without hesitation, a thallus. Both stem and rhizome are traversed by an extremely simple vascular strand.

Rhynia major is considerably the larger plant of the two, but *R. Gwynne-Vaughani* is somewhat the more differentiated, for its aerial stem is studded with hemispherical outgrowths, from which, in some cases, additional branches arose, and often became detached, serving no doubt as a means of propagation. Both outgrowths and adventitious branches are absent from *R. major*, where the stem is merely forked.

It was at one time supposed that the outgrowths of *R. Gwynne-Vaughani* might represent very rudimentary leaves, but later observations have shown that they were developed late in life, usually in connexion with the stomata, and thus formed no part of the original equipment of the plant. They may even have been traumatic in origin.

The reproductive organs are spore-sacs (sporangia) borne on the ends of branches. In *R. major* the sporangia are large—nearly half an inch long; they have a fairly complicated wall, and are filled with well-preserved spores, often still grouped in fours, and in all respects like those of the Higher Cryptogams now living.

The second genus, Hornea, has a tuberous rhizome comparable to the protocorm often found in young Club-mosses, but the stem is like that of *Rhynia major*, on a smaller scale, and just as simple. The sporangia are the most remarkable feature; they are terminal on the branches, as in Rhynia, but in Hornea each spore-sac has a central column of sterile tissue (the columella), over-arched by the spore-bearing layer, exactly as in the capsule of the Bog-Moss, Sphagnum, at the present day. This moss-like feature is very suggestive and has given rise to a good deal of speculation. Another peculiarity of the spore-sac is that its walls are scarcely differentiated from the ordinary tissues of the branch, and that where the branch forks the sporangium forks too. Here, then, it is evident that the sporangium is not an organ *sui generis*, as modern botanists have generally taught, but just the end of a branch, set apart for spore-production.

The Sphagnum-like structure of the spore-sac in Hornea is not without analogy, for just before the Rhynie discoveries, Halle had described, from the Lower Devonian of Norway, a fossil which he named Sporogonites. This is remarkably like the stalked capsule of a Moss in external appearance, and internally (though imperfectly preserved) it proved to have a columella of the same form as that subsequently observed in Hornea. Thus the Rhyniaceæ are not only the simplest vascular plants known; they likewise suggest analogies with the Bryophytes. They have in fact been placed by different botanists in three different sub-kingdoms: in the Pteridophytes, the Thallophytes, and the Bryophytes, on grounds which will be evident from the facts already given. Possibly they may represent a basal group, related at once to the Vascular Cryptogams and the Moss phylum, while at the same time retaining some of the old characters of an Algal stock. But we cannot regard so interesting

[1] Based on a course of lectures given last spring at University College (University of London).
[2] A. H. Church, "The Thalassiophyta and the Sub-aerial Transmigration," Oxford Botanical Memoirs, III, 1919.
[3] Kidston and Lang, "On Old Red Sandstone Plants, showing Structure, from the Rhynie Chert-bed, Aberdeenshire," Transactions of the Royal Soc. of Edinburgh, Part I., vol. 51, 1917; Parts II. and III., vol. 52, 1920; Parts IV. and V., vol. 52, 1921.

a conclusion as established until we are satisfied that the surprisingly simple organisation of the Rhyniaceæ was really primitive.

We can scarcely feel sure that a certain amount of reduction may not have already been undergone, even by this early race of land-plants. The presence of stomata of the familiar type proves that the plants must long have been adapted to a sub-aerial life; at the same time the small number of these organs suggests xerophytic modification, which is quite consistent with a peat-habitat. In fact the habitat warns us that the Rhynie plants may not have been quite typical representatives of the flora of their time. A comparison with the Saltwort (Salicornia) of our mud-flats has even been suggested! Such a plant, however, bears obvious marks of reduction which are wanting in the Rhyniaceæ.

We can do no more than leave the question open. Probably we are justified in accepting Rhynia and Hornea as members of a relatively primitive race, even though their excessive simplicity may have been in some part due to the peculiar conditions under which they had to live.

The presence of Asteroxylon in the same beds might perhaps be taken as an argument against the theory of reduction, for Asteroxylon was, comparatively speaking, a highly organised plant. It is true it had no roots, but the branched aerial stem was well clothed with leaves, and had very much the habit of a Club-Moss (Lycopodium). The anatomy of the stem was also quite complex compared with that of the Rhyniaceæ, though the rhizome was as simple as theirs, and, oddly enough, bore no hairs. Asteroxylon was a larger plant than the others, and had nothing specially primitive in its external aspect. The leaves were peculiar, however, in having a very imperfect vascular supply, for the strand which ran out from the central stele towards each leaf stopped short in the leaf-base and never entered the blade. This is one of three points which suggest a certain degree of possibly primitive simplicity, the other two being the absence of differentiated roots and the structure of the water-conducting elements (tracheides). Though the wood is well developed and rather complex in form, having a stellate transverse section, all the tracheides are of one kind, namely, spiral.

Unfortunately, our knowledge of Asteroxylon is not quite so satisfactory as in the previous cases, for the fructification has never been found in connexion with the plant. There are peculiar naked branches closely associated with a few of the specimens, and with these branches, again, sporangia are found in association. The sporangia are quite different from those of the Rhyniaceæ, but recall the fructification of some of the Carboniferous ferns. If we assume that the naked branches and the sporangia belonged to the Asteroxylon we get a very remarkable combination of characters, as pointed out by Kidston and Lang. While the anatomy and morphology of the vegetative organs are suggestive of Psilotaceæ (a small tropical and sub-tropical family, of uncertain affinities) and Lycopods, the supposed fertile branches and sporangia would link the plant to the ferns. We cannot, however, lay much stress on this surprising synthesis of diverse characters until the connexion of the parts has been established. At present there is no evidence beyond intimate association.

Kidston and Lang are inclined to identify Asteroxylon with Thursophyton, a Middle Devonian plant, of Club-Moss-like habit, hitherto only known from impressions. The fructification assigned by certain writers to species of Thursophyton is, however, of a Lycopodiaceous character, and totally different from that attributed to Asteroxylon.

Asteroxylon is included, together with the Rhyniaceæ, in the class Psilophytales, of which Sir William Dawson's genus Psilophyton, established in the 'fifties of the last century, is the type. There is now no doubt that Dawson's account of Psilophyton, so long discredited, was substantially correct. The plant had a branched rhizome and a forked upright stem, more or less spiny. The fructification consisted of long terminal spore-sacs, much like those of Rhynia. The morphological nature of the spines is disputed; they may be interpreted as rudimentary leaves or as mere outgrowths, like those of *Rhynia Gwynne-Vaughani*. A general affinity between Dawson's plant and the Rhynie fossils is evident, but the exact relations remain doubtful. The late Dr. Arber regarded Psilophyton as identical with Rhynia; Kidston and Lang, on the other hand, have decided to place it in the same family with Asteroxylon. Neither view is established.

It may be mentioned that a possible Psilophyton has recently been recorded by Prof. Halle from the Silurian (Lower Ludlow) of Gothland, an interesting discovery, if confirmed.

Many plants besides the four species of Vasculares were found at Rhynie. The most interesting is a specimen of Nematophycus (or Nematophyton), a genus hitherto generally regarded as belonging to the Algæ; it has a complex structure of interwoven filaments, and some of the species, from other localities, attained a gigantic size. It is very remarkable that a plant with the structure of a highly organised seaweed should occur in a purely terrestrial flora like that of the Rhynie chert-bed. It may suggest that the Algæ of the period were doing a little transmigration on their own account.

A number of genera of the early Devonian flora have been recorded as impressions, showing little or nothing of the internal structure. Space forbids our describing them here. Some are much like Psilophyton, others resemble Club-mosses, while others again have a curiously Alga-like habit. An excellent summary of our knowledge of the Devonian plants generally will be found in Dr. Arber's little volume.[4]

The earlier (Lower and Middle) Devonian flora was for the most part characterised by comparatively simple types of land plants; in some cases, as we have seen, their simplicity was extreme. Even then, however, there is evidence that very much higher forms existed. Thus the fossil known as *Palæopitys Milleri*, from the Middle Old Red Sandstone of Cromarty, was described by its discoverer, Hugh Miller, as a "Coniferous tree," and really has the structure of a well-organised Gymnosperm. Miller himself fully realised the importance of his discovery, which has scarcely received the attention from botanists which it deserves.[5]

(*To be continued.*)

[4] E. A. N. Arber, "Devonian Floras, a Study of the Origin of Cormophyta," Cambridge University Press, 1921.
[5] Hugh Miller, "Footprints of the Creator," edition of 1861, p. 191.

Solar Radiation and its Changes.[1]

WHEN one reflects upon the wide knowledge gained by astronomers concerning stellar and nebular radiation and variability, it at first seems surprising that variation in the visible radiation emitted by the sun has been discovered only recently and with much difficulty. Not until the second decade of this century could the fact be regarded as established, as a consequence of simultaneous determinations of the "solar constant" made by the staff of the Astrophysical Observatory of the Smithsonian Institution, at two stations so widely separated as Bassour in Algeria and Mount Wilson in California. The solar constant is, of course, the estimated value of the intensity of total solar radiation, in calories per square centimetre per minute, at a point just outside the earth's atmosphere, *i.e.* before suffering absorption in transmission to the earth's surface.

The main difficulty arises from the necessity of making practically absolute determinations of the solar constant, because the sun's proximity to us renders it sufficiently unique and solitary in the daylight sky to prevent that comparison with many and similar neighbours which is the foundation of our knowledge of stellar variability. No real progress towards such knowledge regarding the sun could be made until it became possible to determine and allow for the radiation absorbed in the earth's atmosphere. Failing this, even long series of simultaneous observations of the changes in the solar radiation, as received at different points on the earth's surface, are of little use, because any features common to two stations may arise from some common terrestrial cause. A striking example of this was recorded by the Smithsonian observers during the fifty days on which observations were made both at Bassour and at Mount Wilson. On June 6, 1912, a great volcanic eruption occurred at Mount Katmai in Alaska; on June 19 the sky became slightly turbid in Bassour, and a day or two later also at Mount Wilson. The milkiness rapidly increased till in July and August a thick haze overspread the whole sky and cut off more than 20 per cent. of the sun's direct radiation at noonday; yet after applying properly determined corrections, normal and accordant values of the solar constant were obtained at Bassour and Mount Wilson during the above period.

The variability discovered in the sun's radiation is of two kinds; irregular variations occur over periods of a few days or weeks, amounting to a small percentage of the whole intensity, while small variations of longer period are found, showing some correlation with the periodicity of sunspot activity. Considering how marked are the changes in solar-spottedness, and in the accompanying magnetic and auroral phenomena upon the earth, it is remarkable how small are the variations in the main solar radiation. Many attempts have been made to connect the sunspot cycle with meteorological changes likely to depend on the solar radiation reaching the earth, but with very doubtful success—the terrestrial factors which share in determining the weather and crops are too complicated, and it now appears that the long-period changes in the solar radiation are themselves very small. Hence they were bound to remain undetected till direct methods and appropriate instruments were devised which made possible a frontal attack upon the problem. The method which has proved successful is due to S. P. Langley, and the spectro-bolometer which he invented (in 1880) is one of the chief instruments employed; but many improvements and additions both of method and in the instrumental equipment have been since made, and largely by the staff of the Smithsonian observatory under its director Dr. C. G. Abbot.

Langley's method is, briefly, as follows: Absolute measurements of the total solar radiation reaching the earth's surface are made with an instrument (the pyrheliometer) which indicates the heat energy absorbed by a blackened silver disc exposed to the radiation. It is claimed that the error of a single reading with this instrument is less than 1 per cent., and inter-comparison of pyrheliometers over periods of several years shows that the scale is free from secular changes exceeding 1 per cent. Such absolute observations are made at frequent intervals during a forenoon or afternoon, with the sun at different altitudes from 15° upwards; the measurements vary on account of the varying absorption as the radiation passes through a greater or lesser length of atmosphere.

The correction for the absorption is obtained with the aid of the spectro-bolometer, which consists essentially of a wire on which radiation of a particular wave-length is directed, after passing through a suitable prism. The resulting rise of temperature in the wire is measured by the change in its electrical resistance, and by passing the whole available spectrum over the wire a "bolograph" showing the energy-intensity curve over the solar spectrum is obtained. Such bolographs, corresponding to different successive altitudes of the sun, show the absorption in all parts of the spectrum during the passage of radiation through lengths of the atmosphere proportional to the secants of the sun's zenith distance; their comparison makes it possible to correct each bolograph for the absorption. In certain regions of the energy-curve where powerful selective absorption occurs by water and other atmospheric vapours, it is assumed that the absorption bands are absent outside the atmosphere, the curve being completed by interpolation between adjacent parts of the curve on either side.

While highly sensitive, the bolograph gives relative rather than absolute measures of solar radiation, and the scale of the uncorrected bolograph is obtained by comparing its area with the value of the total radiation as measured by the pyrheliometer. The bolograph corrected for absorption then gives the value of the solar constant. It is estimated that the probable error of an ordinary daily determination of the latter is from 0·2 to 0·3 per cent. as regards the relative values from day to day, *i.e.* omitting the probable error of the pyrheliometer scale value. The whole daily error should therefore be well below 1 per cent. under good conditions, though at times irregular or systematic errors of larger magnitude may occur.

The absolute value of the solar constant, determined from 1244 observations, mainly at Mount Wilson

[1] "Annals of the Astrophysical Observatory of the Smithsonian Institution." Volume iv. By C. G. Abbot, F. E. Fowle, and L. B. Aldrich. Pp. xii+390. (Washington, 1922.)

(1912–20), but also at Calama in Chile (1918–20), is given as 1·946. Dr. Abbot admits, however, a criticism by Kron, to the effect that this value may be 2 per cent. too low owing to a systematic influence tending to magnify the measured atmospheric transmissibility for ultra-violet rays. The error does not affect the evidence for variability in the solar radiation.

The above value is slightly greater than the mean (1·933) for the epoch 1902–12, and it is suggested that the increase is associated with the greater average solar activity during the later period. Whether this be so or not (and the more detailed comparison of values of the solar constant with sunspot numbers scarcely strengthens the evidence for such a connexion), the really remarkable result is the minuteness of the change; the solar agent which affects the diurnal variation of terrestrial magnetism must vary by 20 per cent. or more, instead of ½ per cent. or 1 per cent., as here. There is, of course, a very slight compensation for any general increase of solar emissivity at times of many sunspots, owing to the diminution of emitting surface caused by the presence of the low-temperature spots; if there are also absorbing vapours above the spots, the compensation may not be merely slight; an appreciable drop (about 5 per cent.) in the solar constant coincided with the passage of a very large group of sunspots across the sun's disc in March 1920.

The short-period "solar-constant" variation, of amount from 2 to 10 per cent., has been further confirmed by simultaneous observations at Mount Wilson and at Calama, Chile; these stations are about 5000 miles apart, on opposite sides of the equator, and at different altitudes. Their observations show a moderate degree of correlation (0·491). Attempts have been made by Dr. Abbot and his colleagues to find connexions between the variations of the solar constant and the variations of contrast of brightness on the sun's disc which have been revealed by observations of the distribution of radiation over the sun's surface. Such measures have been carried on now for more than eight years by the Smithsonian observatory. The association between the two phenomena, if real, is very complex, high contrast sometimes accompanying high, and sometimes low, values of the solar constant. A correspondingly complex theory is propounded to account for this, but a much longer series of observations is required to test the theory. Dr. Abbot urges the desirability of other observatories taking up solar-constant work, especially in view of the possibility that variations of radiation have predictable meteorological consequences, as Clayton's studies might suggest.

Various other cognate researches have been made by Dr. Abbot and his colleagues, Messrs. Fowle, Aldrich, Moore, and Abbot, during the period, since 1912, dealt with in the volume of Annals before us. Variations in the solar radiation have been tentatively sought by observing the changing brightness of the planets. The sun's total radiation has also been measured, at various terrestrial altitudes, from sea-level to high mountain stations, and beyond, up to 25,000 metres, by sounding balloons. A new empirical method of determining the solar constant by observations occupying only fifteen minutes in all has been introduced at Calama; this removes one of the chief sources of error in the longer method, namely, real variations in atmospheric transparency during the observations. In the new method the amount and character of the atmospheric absorption at the time of a pyrheliometer observation is inferred from a measure of the brightness of the sky in a zone 15° from the sun, and from the intensity of a particular water absorption band observed by means of the bolograph. Many observations of the brightness and transmissive power of the atmosphere have been made in the course of this and the other parts of the solar-constant work. Laboratory studies have been made on the absorption of long-wave radiation by water vapour, carbon dioxide, ozone, and by many common solid substances. The reflecting power of clouds has been measured by balloon observations at Mount Wilson in 1918; the ratio of reflection found was 78 per cent., independent of the solar altitude. From this the albedo of the earth is estimated at 43 per cent.

On account of over-frequent cloud and haze at Mount Wilson the solar-constant work carried on there since 1915 has been transferred to Mount Harqua Hala in Arizona, and the Calama station in the plain has been removed to Mount Montezuma, a few miles away. For a short time in 1917–18 observations were made at Hump Mountain in North Carolina, but the situation proved too cloudy. It is interesting to note, however, that one excellent observation was made at a lower air temperature than any experienced elsewhere during a complete solar-constant observation; both the hands and feet of the observer with the pyrheliometer were frozen in the course of the measurements!

Obituary.

W. H. Wesley.

WILLIAM HENRY WESLEY, who died on October 17, at the age of eighty-one years, was appointed assistant secretary of the Royal Astronomical Society in 1875, and continued in that office till his death, a period of forty-seven years. He had excellent qualifications for the post, being most orderly and methodical in all secretarial and editorial work, and having great skill as a draughtsman and engraver, as was exemplified in his engravings of Dr. Boeddicker's drawings of the Milky Way, and the illustrations of the corona in Mr. Ranyard's memoir on solar eclipses. It used to be said that Wesley knew the corona better than any man living, although he had never seen it; however, after an unsuccessful effort in Norway in 1896, the equatorial *coudé* at Algiers was put at his service by M. Trépied in 1900, when he made a detailed drawing in the short duration of totality (64 seconds) and expressed his opinion that the eye was no more efficient than the photographic plate for this work. He made combination drawings from the negatives obtained by the Greenwich staff in the eclipses of 1898,

1900, 1901, 1905, and these will probably be reproduced.

Fellows of the Royal Astronomical Society will long remember Wesley's readiness to help them in their researches, and to put his intimate knowledge of the society's library at their service. He was an original member of the British Astronomical Association, and served as vice-president for many years; on one occasion he delivered the presidential address in place of the late Mr. Green. A. C. D. CROMMELIN.

PROF. C. MICHIE SMITH.

CHARLES MICHIE SMITH, who died on September 27, was born on July 13, 1854, at Keig, Aberdeen. He studied at Aberdeen and Edinburgh, graduating as B.Sc. in 1876. He was appointed professor of physics at the Christian College, Madras, in the same year, and in 1891 became Government Astronomer at Madras. In 1899 he brought out the New Madras General Catalogue of 5303 stars: the low latitude of Madras gives its star catalogues special importance, since they serve to link the northern and southern catalogues.

Michie Smith observed the annular eclipse of 1894, and the total one of 1898 at Sahdol, obtaining some beautiful large-scale coronal photographs. He also observed the Leonid meteors in 1899, including 37 of the first magnitude (Mon. Not. R.A.S., vol. 60), and published an extensive record of meteors seen at Madras from 1861 to 1890. He also observed the Zodiacal light, and wrote the article on this subject in the "Encyclopædia Britannica" (9th edit.).

Regular meteorological observations were made at Madras, and in 1893, Michie Smith published those of the years 1856 to 1861. He also contributed papers to the Royal Society of Edinburgh on the eruption of Bandaisan, the determination of surface-tension by measurement of ripples, and on atmospheric electricity and the absorption spectra of vegetable colouring matters. It was under his initiative that the mountain observatory at Kodaikanal was inaugurated in 1899, which has played such an important part in the extension of our knowledge of solar physics. He presided over the two observatories from 1899 till his retirement in 1911, when he was succeeded by Mr. Evershed.

WE regret to announce the death of the eminent scholar and editor, Dr. James Hastings, at the age of seventy-one years. The various Dictionaries of the Bible published under his control have enjoyed much popularity, combining with the orthodox position the results of modern criticism. But his greatest work was the "Encyclopædia of Religion and Ethics," the publication of which began in 1908 and ended with the twelfth volume in 1921. Like all works of the kind, it is uneven, but to the student of comparative religion, ethics and philosophy, anthropology and folklore, it is of the highest value. Hastings was a model editor, quiet and unassuming, sparing no pains to verify a fact or a reference; he maintained the most agreeable relations with his many contributors, some of whom must have tried his patience sorely. His fault, if it be a fault, was excessive kindness and hesitation in using his blue pencil when he was dealing with men who were recognised authorities on the subjects which they undertook. The war, which interfered with his arrangements with foreign scholars, added much to his anxieties, and the work must have come to a temporary end if he had not been generously supported by his publishers. He had planned a general index of the Encyclopædia, which will add much to its value for the working scholar. It is to be hoped that the scheme for the index was drawn up before his sudden, untimely, and much regretted death.

IN the *Chemiker Zeitung* of September 28 the death is announced on September 15 of Prof. F. Nobbe, of the Forestry Academy of Tharandt, the founder of the research station of plant physiology and the first station for seed control.

WE notice with much regret the announcement of the death on October 26, at sixty-six years of age, of Dr. C. G. Knott, reader in applied mathematics, University of Edinburgh, and on October 28, in his eighty-fifth year, of Prof. A. Crum Brown, emeritus professor of chemistry in the same university.

Current Topics and Events.

MUCH anxiety is felt in this country as to the position and prospects of the Royal College of Science, Dublin, under the Irish Provisional Government. By a sudden decree, the college was closed on October 1—a day before the new session would have opened. It was announced that a bomb had been found in the building, and this provided a plausible excuse for the action taken. No students had, however, been admitted to the college since June 30, and the circulation of the rumour as to the discovery of the bomb was known to be merely a means of suggesting that the college was a centre of disaffection and that in the interests of public safety it should be closed. For a week or two afterwards the teaching was carried on in buildings lent by the National University, but a second decree was made on October 16 ordering the students, about four hundred in number, to enter the National University classes, an arrangement against which both professors and students strongly protested. A compromise may be effected, but meanwhile the Royal College of Science is in the complete occupation of the military, and no one in authority will say that the building will be restored to its original purposes when military necessity ceases. It would be nothing short of a calamity if an institution in which so much valuable scientific work has been carried on for many years should have its activities abruptly ended to serve purely political purposes. The college is unique in Ireland; its equipment cost more than 250,000*l*. and no other

institution or university in that country can offer the same facilities for training. It must be heartbreaking to see the practical equipment and apparatus, the fine electric machinery plant, engineering department, and laboratories generally, used for kitchens and bedrooms and at the mercy of military forces unfamiliar with their significance or value. It is almost impossible to get exact information as to the actual position of things in Dublin, but if conditions are half so bad as have been described to us, men of science and scientific institutions should unite to bring them to the notice of their colleagues in other parts of the British Isles and the world of progressive knowledge in general, in the hope that provision for the scientific instruction and research much needed by Ireland will not be curtailed but extended in the near future.

THE Marquess of Crewe has accepted the invitation of the council of the British Science Guild to succeed Lord Montagu of Beaulieu as president of the Guild. Lord Crewe has always taken much interest in the promotion of scientific research, and it was while he was Lord President of the Council in 1915 that the Government scheme for aiding the formation of Industrial Research Associations was announced by him. The British Science Guild is not directly concerned with the methods and results of research in the same way as are the various scientific and technical societies, but with securing adequate facilities not only for extending scientific knowledge itself but also for using it for national progress. Its relation to such societies is similar to that of the Navy League to the navy; and the need of such a body, watching and intervening on behalf of science, and in the interests of administrative efficiency and national development, is as great to-day as ever it was. We understand that the Guild proposes shortly to make a wide appeal for support to extend its activities and to enlighten the general public as to the significance of scientific work and thought in modern civilisation by means of leaflets, lectures, conferences, and so on. The campaign is a promising one, and for the sake of science as well as for national security, we trust it will be markedly successful.

AMONG the scientific men who lived during the Revolutionary Era in France few were held in higher esteem than Claude Louis Berthollet, the centenary of whose death occurs on November 6. Celebrated for his discovery, in 1785, of the composition of ammonia and, in 1786, of the bleaching properties of chlorine, he was one of the earliest converts to the new ideas of Lavoisier, and with Lavoisier, Fourcroy, and Guyton de Morreau, compiled the "Méthode de Nomenclature Chemique." During the Revolution his organising powers were devoted to maintaining a supply of saltpetre for the making of gunpowder, while with Monge and Clouet he did much to improve and extend the manufacture of steel. He also played a prominent part in the reorganisation of the Academies and the inauguration of the National Institute. Like Monge, he was a favourite with Napoleon and was one of the group of learned men who accompanied the young conqueror to Egypt. Among Berthollet's writings was his "Statique Chimique," published in 1803. He was the founder of the famous "Société d'Arceuil," of which Laplace, Biot, and Gay-Lussac were members.

THE secretary of the Swedish Medical Society has favoured us with the following particulars of the Anders Retzius medal which was awarded recently to Sir Charles Sherrington. The Anders Retzius foundation was given to the society on October 13, 1896, by Mrs. Emilia Retzius in memory of the hundredth anniversary of the birth of her late husband, Prof. Anders Retzius; and it is intended to promote studies of normal anatomy and physiology. From this foundation the Anders Retzius gold medal was for the first time awarded by the society to Albert von Kölliker in the year 1897. It has since been awarded successively on every fifth year to Carl Voit, Gustaf Schwalbe, John Newport Langley, and Oscar Hertwig, alternately in recognition of their prominent anatomical and physiological researches. The medal is sixty-nine millimetres in diameter, was designed by the Swedish medallist E. Lindberg, and represents Anders Retzius's portrait in profile.

MR. W. FRENCH, writing from the Storey Institute, Lancaster, directs our attention to a letter from Prof. A. C. Seward, published in the *Lancaster Observer* for September 22, referring to the state of the tombstone marking the grave of the parents of Sir Richard Owen and appealing to Lancastrians to contribute the comparatively small amount required for its restoration. Mr. French suggests that there may be many scientific men yet living who owe much of their success and inspiration to the writings and teachings of Sir Richard Owen, and would be willing to acknowledge in part their debt to him by contributing to the restoration of the tombstone of his parents. The estimated cost of the project is about 30*l*., and Mr. French is willing to receive subscriptions and to give any further information that is required. We feel sure that readers of NATURE will share the desire of Prof. Seward and Mr. French that anything associated with the memory of so distinguished a man of science should be preserved and treated with the greatest reverence.

IT has been announced in our columns (September 16, p. 394) that nearly 850*l*. had been subscribed in this country in support of the Pasteur centenary celebrations. This sum has been forwarded to the general treasurer of the fund, M. Th. Héring, who, in his reply acknowledging the receipt of the gift, states that any surplus of funds remaining after providing the monument at Strasbourg will pass to the Pasteur Foundation, which will probably institute Pasteur prizes for needy students. In February next, the Alliance Française, of 41 Fitzroy Square, W.1, is entertaining for a few days MM. Vallery-Radot, father and son, relatives of Pasteur, and Dr. Pasteur Vallery-Radot will give an address on the work of his illustrious grandfather. MM. Vallery-Radot will afterwards be entertained at dinner, probably at the Vintners' Hall.

IN the *Daily Mail* of October 23 appears a note on the discovery of a human skull and bones in an ancient gold-working at Gwanda, Rhodesia. It is based upon an account of the discovery by Mr. Duncan Simpson, by whom the bones were found in July last. They lay under twenty feet of débris, and their position would suggest that the miner was working on the face of the reef when he was killed by a fall of the rock. This is supported by the fact that a large stone hammer lay near by, which, it may be assumed, he was using at the time. The bones are now in charge of Dr. Arnold of the Rhodesian Museum and are to be submitted to expert investigation. It is stated that on a cursory examination they are thought to be those of a Bantu. If, as the circumstances suggest, the remains are those of one of the original miners of the ancient gold-workings, in which this part of Rhodesia abounds, they are the first to be discovered. The confirmation of their Bantu origin would have an important bearing upon the problem of the origin of these gold-workings and of the highly developed ancient culture of Rhodesia which has so often been the subject of controversy. While it is highly probable that the workers were the slaves of a higher race, as suggested in the *Daily Mail* article, the Bantu origin of these early miners, in view of the comparatively late incursion of that race into this area, would preclude a very high antiquity for these workings.

A SNAP of cold and severe weather was experienced over the British Isles during the closing days of October, and temperatures were exceptionally low for so early in the winter season. Bitter easterly winds were prevalent under the controlling influence of a region of high barometer centred over Iceland and an area of low barometer readings situated over France and the Bay of Biscay. In the English Channel and on our south coasts the east winds attained the force of a gale. Snow fell in Cornwall and at many places in the southern counties on Saturday, October 28. According to the reports from the Meteorological Office, the thermometer on October 28 and 29 failed to reach 50° F. in any part of the Kingdom, whilst on October 29 the maximum at Falmouth, Newquay, Lympne, and Hampstead was only 39° F. and at night sharp frost was generally experienced, the exposed thermometer falling to 20° F. in many places. The Greenwich temperature records from 1841 show that in six years, 1859, 1869, 1873, 1880, 1890, and 1895, the maximum day temperature in October failed to attain 40°, on a single day, at least, subsequent to October 20. At Eastbourne the highest temperature on Sunday, October 29, was 42° F., and on three mornings, October 26, 27, and 29, the lowest temperature in the shade indicated a frost. October was generally cold and fairly dry in most parts of England, with a large amount of easterly wind, and was in marked contrast to the warm and bright weather experienced in the corresponding month of last year.

THE anniversary dinner of the Royal Society will be held at the Hotel Victoria (Edward VII. rooms) on St. Andrew's Day, Thursday, November 30.

THE annual exhibition of scientific apparatus organised by the Physical Society of London and the Optical Society will be held on January 3 and 4 next.

AT the first ordinary meeting of the new session of the Royal Geographical Society, to be held on November 13 at 8.30 P.M., at the Aeolian Hall, a paper will be read by Commander Frank Wild on the work of the *Quest*.

THE Huxley Lecture of Charing Cross Hospital Medical School will be delivered at the school on Wednesday, November 8, at 3 o'clock, by Sir Arthur Keith, who will speak on "Evolutionary Tendencies in Man's Body." At 4 o'clock on the same day, at London Hospital Medical College, Dr. Percy Kidd will deliver the Schorstein Memorial Lecture. The subject will be "Forty Years in the History of Tuberculosis."

AT a meeting of the Royal Society of Edinburgh on October 23, the following officers and members of council were elected: *President*: Prof. F. O. Bower. *Vice-Presidents*: Sir J. A. Ewing, Prof. J. W. Gregory, Major-General W. B. Bannerman, Dr. W. A. Tait, Principal J. C. Irvine, Lord Salvesen. *General Secretary*: Dr. C. G. Knott. *Secretaries to Ordinary Meetings*: Prof. J. H. Ashworth, Prof. R. A. Sampson. *Treasurer*: Dr. J. Currie. *Curator of Library and Museum*: Dr. A. Crichton Mitchell. *Council*: Prof. F. G. Baily, Dr. R. Campbell, Prof. J. Arthur Thomson, Dr. H. S. Allen, Sir Robert Blyth Greig, Dr. J. Ritchie, Prof. E. M. Wedderburn, Prof. T. H. Bryce, Prof. J. Y. Simpson, Prof. D'Arcy W. Thompson, Sir James Walker, Prof. E. T. Whittaker.

IN her presidential address, delivered on October 19, to the Society for Constructive Birth Control and Racial Progress, Dr. M. C. Stopes dealt with the ideals and present position of constructive birth control. She stated that the social ideal urgently needed to-day is the revision of our present mistaken tendency to breed from defective stock more than from good and healthy stock. Acting as a motive force is also the individual human commiseration for the sufferings endured by unhealthy, over-burdened slum women, involuntarily the mothers of degenerate stock. Dr. Marie Stopes is of opinion that the Utopian idea is attainable through the use of scientific knowledge in such a way as to secure the increase from the best, and to decrease the population of low-grade human beings.

MESSRS. W. HEFFER AND SONS, LTD., booksellers, Cambridge, have recently purchased the interesting and valuable library of Prof. R. B. Clifton, late professor of natural philosophy in the University of Oxford. They have a catalogue in preparation. A copy will be sent post free on application.

WE have received from Mr. W. Rodier, 327 Collins Street, Melbourne, a letter and some pamphlets dealing with the rat problem as bearing upon the article by Mr. Alfred E. Moore in our issue of May 20 (vol. 109, p. 659). Mr. Rodier's scheme for the extermination of rats, known as "The Rodier System," which consists in liberating all the males trapped, is of course well known and its merits thoroughly appreciated by all interested in the destruction of

the rat. Mr. Moore, to whom we submitted Mr. Rodier's communication, sends us the following comments upon it: "Boelter, who joined me soon after I had initiated the British war on rats and mice, agreed with me that if we could get international, unified, and synchronised war on the rat, then and not till then could we hope to have any success from Mr. Rodier's method; we agreed that our first step must be to get the public fully to appreciate the disastrous nature of the rat menace, but that we could not afford to postpone rat destruction by all and every means until the day when unified effort was forthcoming. If Mr. Rodier agrees to work for an International Commission to bring about a proper understanding of the rat problem and concerted action, then I am sure all of us would gladly co-operate; but until we can get the public mind fully alive to the extent of the issue, I am sure it would be just as reasonable during the fly season to catch as many flies as possible and to liberate all the males: in this instance at any rate we should have a fair chance of seeing the progress of our work."

READERS of NATURE interested in topography may like to have their attention directed to a catalogue of some 230 books, maps, and engravings relating to London and its vicinity just issued by Mr. F. Edwards, 83 High Street, Marylebone, W.1.

THE useful quarterly list of new books and new editions added to Lewis's Medical and Scientific Circulating Library for the months July to September has just been received. Copies are obtainable free of charge from Messrs. H. K. Lewis and Co., Ltd., 136 Gower Street, W.C.1.

MR. W. H. ROBINSON, 4 Nelson Street, Newcastle-upon-Tyne, has recently issued a catalogue of some 300 second-hand books of science. The prices asked seem very reasonable. An interesting item is a copy of the first edition in English of The Anatomical Exercises of Harvey, concerning the Motion of the Heart and Blood; with the Preface of Zechariah Wood, Physician at Roterdam, to which is added Dr. James De Back, his Discourse of the Heart, containing a defence of Harvey's work.

A DIRECTORY for the British Glass Industry is being compiled under the auspices of the Society of Glass Technology. It will contain in classified form the names of all firms, associations, societies, trade unions, educational and research institutions interested in the manufacture and wholesale supply of glass and glass articles, and in the supply of raw materials, plant, and machinery to the industry. It is hoped to publish the volume by the end of the present year.

Our Astronomical Column.

RECENT METEORS.—Mr. W. F. Denning writes that two large meteors were seen at Bristol on October 17 at 7.15 and 10.46. The first of these descended just under the "Pointers" in Ursa Major from $164^\circ+52^\circ$ to $164^\circ+45^\circ$, and moved very slowly. The other meteor traversed an unusually long path of 113 degrees, the flight being from $163^\circ+74^\circ$ to $330^\circ-6^\circ$. The duration was about six seconds, and the meteor threw off a bright streak all along its extended course. The radiant point was near the horizon in $152^\circ+39^\circ$, but no further accounts of the object have yet been received.

The October meteoric shower has been fairly well observed this year, a remarkable succession of clear nights having occurred between October 10 and 21. The chief showers have been from Orion and Aries. Mr. Prentice at Stowmarket saw 246 meteors between October 10 and 18 in 34 hours of watching. The chief radiants in activity were determined by him as follows:

α Arietids .	31°	$+19^\circ$	8 Meteors, October	13-15.
ϵ Arietids .	$41\frac{1}{2}^\circ$	$+22^\circ$	17 ,, ,,	14-18.
υ Orionids .	90°	$+16^\circ$	10 ,, ,,	18.
ζ Geminids .	98°	$+15^\circ$	8 ,, ,,	14-15.

These various showers are well known at this period of the year. The Arietids are slow-moving, brilliant meteors, while the Orionids and Geminids are swift, streaking meteors.

OCCULTATION OF ALDEBARAN.—On Monday next, November 6, the moon will occult the bright star Aldebaran in Taurus. The disappearance takes place at $10^h\ 8^m$ G.M.T., and the reappearance at $11^h\ 20^m$ G.M.T.

COMETS.—Numerous observations are to hand of the comet discovered by Dr. Baade on October 19. The comet is easily visible in a moderate telescope, and should be observable for some months. It is, however, receding from the sun and earth. The following elements are by Mdlle. Vinter Hansen, from Copenhagen observations on October 22, 23 and 24:

$$T=1922 \text{ Oct. } 16{\cdot}5701 \text{ G.M.T.}$$
$$\left.\begin{aligned}\omega&=114^\circ\ 32'{\cdot}07\\ \Omega&=219^\circ\ 50'{\cdot}89\\ i&=\ 51^\circ\ 47'{\cdot}00\end{aligned}\right\}1922{\cdot}0.$$
$$\log q=0{\cdot}35890.$$

EPHEMERIS FOR GREENWICH MIDNIGHT.

	R.A. h.	m.	s.	N. Decl.		log r	log Δ.	Mag.
Nov. 6.	20	28	4	32°	36′·0			
10.	20	37	43	31	28 ·1	0·3622	0·3035	10·1
14.	20	47	28	30	21 ·4			
18.	20	57	18	29	16 ·2	0·3646	0·3150	10·2
22.	21	7	10	28	13 ·0			

The comet should be looked for high up in the south-west soon after sunset.

The search ephemeris lately given for Perrine's periodic comet did not include perturbations. M. Kasakov of Moscow finds that these are large, and gives the following elements:

$$T=1922 \text{ Dec. } 25{\cdot}2.$$
$$\left.\begin{aligned}\omega&=167^\circ\ 15'{\cdot}21\\ \Omega&=242^\circ\ 18'{\cdot}53\\ i&=\ 15^\circ\ 42'{\cdot}56\end{aligned}\right\}1922{\cdot}0.$$
$$\phi=\ 41^\circ\ 15'{\cdot}63$$
$$\mu=537''{\cdot}538.$$

EPHEMERIDES FOR GREENWICH MIDNIGHT WITH TWO ASSUMED DATES OF PERIHELION.

	Perihelion Dec. 21.2. R.A. h.	m.	s.	N. Decl.		Perihelion Dec. 25.2. R.A. h.	m.	s.	N. Decl.	
Nov. 10.	21	14	5	5°	29′	20	58	7	3°	9′
18.	21	35	11	4	35	21	17	53	2	33
26.	21	59	34	3	52	21	40	32	2	9
Dec. 4.	22	27	1	3	21	22	5	53	1	58

It is some 26° south of the other comet, but considerably fainter.

Research Items.

A LONG BARROW IN BRECONSHIRE.—In the October issue of *Man*, Mr. C. E. Vulliamy describes the results of his excavations of a long barrow at Talgarth in Breconshire, on a foothill of the Black Mountain range. The chamber and its contents had been disturbed, but not in recent times. At an early stage a calcined thigh-bone of a youth was found, but lower down there were abundant human remains, much broken and seldom lying in anatomical relation to each other, but showing no evidence of cremation. Sir Arthur Keith, who has examined the fragments, finds one skull of a man about forty years of age, the cephalic index 70, a very narrow, relatively high, and rather small head, 20 mm. narrower than previously recorded in Neolithic skulls from Wales. Associated with the human remains were bones of the pig, ox, goat, and cat, and quantities of flint flakes and scrapers are scattered over the neighbourhood.

A THIRD-CENTURY BIRMINGHAM.—Preliminary excavations have just been completed on the site of what the *Times* calls "a third-century Birmingham," Ariconium, in the Wye valley between Monmouth and Gloucester, near Weston-under-Penyard, three miles from Ross. Over an area of more than 100 acres the earth is full of smelting refuse; evidently a great iron industry flourished there, the iron ore being brought from the Forest of Dean. The only classical reference to the place is in the Itinerary of Antonius, compiled about 150 A.D., and in the fourteenth century the Benedictine monk Richard of Cirencester refers to it. Some buildings have been found, the walls of which were decorated in column. A large quantity of pottery, fragments of Samian ware, and a coin of Domitian dated 87 A.D. were also discovered. Ariconium seems to have arisen as a halting-place on the Roman road from Caerleon to Silchester in the first century, and it became a busy industrial town in the third. The results of these excavations justify their continuance on a wider scale.

BACTERIOLOGY OF CANNED MEAT AND FISH.—The results of an investigation by Dr. W. G. Savage and Messrs. R. F. Hanwicke and R. B. Calder on the bacteriology of canned meat and fish have been published by the Food Investigation Board as Special Rep. No. 11 (H.M.S.O., price 2*s*. 6*d*. net.). The report is based on the examination of 344 samples, the object being to ascertain the character of bacteria concerned in the spoilage of these canned foods. Moulds and yeasts are of rare occurrence and probably of little importance. Obligate anaerobic bacilli are rarely present in sound tins, but were nearly always associated with obtrusively decomposed conditions in the tin. Sporing aerobic bacilli are frequent in sound samples, and many of them must be regarded as potential causes of decomposition; they are unable to develop in sound tins from which air is excluded and persist as harmless spores. Non-sporing bacilli were found in many samples, their importance depending upon their biological characters. Thus, strains of *B. proteus* are important causes of decomposition. Thermophilic bacteria (*i.e.* bacteria growing best at 55° C.) were searched for and found to be widely prevalent but, being non-proteolytic, are unlikely to cause spoilage. Micrococci are infrequent and as a group cannot be regarded as a cause of spoilage, though they may assist more proteolytic types of organisms. Nearly 62 per cent. of sound tins are not sterile, the worst offenders being crab and lobster. Sterility itself is therefore not a criterion of soundness, and these surviving bacteria do not in any way injure the foods in which they are present owing to their inability to multiply and produce decomposition under the conditions existing. Suggestions are made respecting the process of manufacture so as to reduce spoilage to a minimum.

FLOWER STRUCTURE IN THE LECYTHIDACEÆ.—Prof. McLean Thompson has published a further study of floral morphology in the Lecythidaceæ, a peculiar tropical family with large fruits, related to the Myrtaceæ (Trans. Roy. Soc. Edin., Vol. 53, Part I., No. 13). The present paper is devoted to a study of the flowering and certain stages in the floral development of *Napoleona imperialis*, the first member of the West African genus Napoleona to be described, in 1786, by a French writer. The peculiarities of the flower include so-called inner and outer corollas with a series of petaloid filaments between them. Many interpretations have been placed upon these structures. The floral development indicates that the petaloid filaments and the outer corona have taken the place of the outer cycles of stamens in the Myrtaceous flower, as Bentham supposed. The style is surrounded by a fleshy glandular disc which is considered to be a remnant of an inner stamen-bearing whorl.

HAWAIIAN GRASSES.—A comprehensive account of the grasses of the Hawaii islands, which is based on special collections made by the author in 1906, and on all accessible material gathered by other observers, is provided in Memoirs of the Bernice Pauahi Bishop Museum, Vol. VIII. No. 3 (Honolulu), "The Grasses of Hawaii," by A. S. Hitchcock. The preliminary discussion deals with the distribution from an ecological standpoint, with the chief agricultural grasses, and with introduced species. A large number of the grasses of the islands have been introduced, 83 species in all, mostly from Europe, a few from Australia and the East Indies. Many of the 47 native species are endemic, and most of the others have extended northwards to Hawaii from the East Indies and the southern Polynesian islands. Of the 39 endemic species 7 are annuals, all belonging to the genus Panicum. The second part is systematic and gives a full description of each species, the necessary keys being provided; 9 new species are described, together with a new section of Poa, Siphonocoleus sect. nov. The treatise should provide a useful and well-arranged reference work for students of the Gramineæ.

WEST INDIAN HURRICANES.—An article on the formation and movement of West Indian hurricanes by Mr. E. H. Bowie of the U.S. Weather Bureau appears in the U.S. *Monthly Weather Review*, April 1922. The area of first appearance is described as extending from latitude 10° to 25° N. and from longitude 56° to 95° W. During a period of 35 years, 90 per cent. of the West Indian hurricanes are said to have had their origin within and not without this area. It is asserted that some years pass without hurricane formation, while other years are notable for hurricane frequency. The origin of a hurricane is by no means certain, and the author states it is even now difficult and next to impossible to say which of the many hypotheses is the correct one. The prevalent supposition of the origin is the meeting of adverse currents, having different temperatures, which produce gyratory motions of the atmosphere. Many men of science are of opinion

that tropical cyclones are essentially convectional phenomena. Observations in the free air in and around a tropical cyclone are not available. Dr. V. Bjerknes, in his theory of the polar front, has recently given a new conception of the part that local wind systems play in the formation of cyclones. The author states that it would seem that the cause of the origin of the tropical cyclone may be found in the counter current theory as to initiation of the cyclone centre, while the convective theory accounts for its maintenance after having started. Much information is given on the movement of hurricanes, and there are numerous charts showing the travelling centres in association with the surrounding distribution of atmospheric pressure.

LOCAL OR HEAT THUNDERSTORMS.—The U.S. *Monthly Weather Review* for June gives an interesting and instructive account of the development of thunderstorms by Prof. C. F. Brooks, of the Clark University, which was presented before the American Meteorological Society in April last. The supply and action of the ascending and descending currents of air are explained, as well as the formation and effect of rain in the development of the storm. The physical make-up of the thunderstorm is said to develop quickly into a central descending and outflaring current of cold air, surrounded by a cone of rising warm air, and still farther out by a zone of descending air. A thunderstorm is described as the result of relatively large streams of air in violent convection attended by abundant condensation of moisture. With reference to the rapid rising of air in cumulus clouds that are growing into cumulonimbus, the author remarks that on different occasions his rough measurements have shown upward motions of 3, 4, and 7 metres per second in the tops of cumulus clouds. Aviators and aeronauts who have been within active portions of cumulo-nimbus clouds have experienced great bumpiness owing to the strong up-and-down currents. Violent convection is said to be caused by the instability accompanying a large lapse rate in temperature. Abundant condensation of moisture is essential to the start of a thunderstorm. The gist of the communication is the predicting of local thunderstorms, and certain questions are formulated for the forecaster relative to streams of air, convection, and condensation. It is suggested that the conditions be tabulated and that use be made of a + or − answer, the summing up of which will indicate whether local thunderstorms are probable. Important information is given as to where local thunderstorms originate.

THE SPHERE-GAP VOLTMETER.—When it is necessary to measure the maximum or peak voltage of an alternating current from a transformer or induction coil the sphere-gap voltmeter is often used, as its indications are independent of the humidity of the air and of the form of the voltage wave. The following particulars of such an instrument at the National Physical Laboratory, furnished by Dr. E. A. Owen in the October issue of the *Journal of the Röntgen Society*, will prove useful. The spheres, 7·62 cm. in diameter, are mounted on ebonite pillars 21 cm. long, with sulphur rings 5 cm. long let into them for additional insulation. One sphere is fixed and the other supported on a slide which can be moved towards the fixed sphere by means of a screw. A scale on the slide gives the distance apart of the spheres at their nearest points. The spheres are connected to the supply and are moved slowly towards each other till a spark passes. The peak voltage is then deduced from the distance apart by the following data: 1 cm. 32·7 kilovolts; 2, 60; 3, 86; 4, 196; 5, 124; 6 cm. 141 kilovolts.

OZONE.—Prof. E. H. Riesenfeld, of Berlin, has recently described (*Chemiker Zeitung*, October 7) the preparation and properties of pure ozone. Ozonised oxygen containing 10-15 per cent. of ozone was liquefied in exhausted glass bulbs by cooling in liquid air. The deep blue liquid, on exposure to reduced pressure, gave off mainly oxygen, and at a certain composition separated into two layers: the upper, dark blue, layer was a solution of ozone in liquid oxygen; the lower, deep violet-black, layer was a solution of oxygen in liquid ozone. The lower layer, formerly considered to be pure ozone, contains about 30 per cent. of oxygen at −183° C. The oxygen was pumped off from it, and pure liquid ozone (B.P. −112·4° C.) obtained. The vapour density of 48 (O_3) was found by Dumas' method. On cooling in liquid hydrogen, solid ozone, in violet-black crystals, M.P. −249·7° C. was formed. The gas, deep blue in colour, is, in the absence of all catalysts, remarkably stable. Pure gaseous ozone can be exploded by an electric spark, but some remains unchanged. This would be expected from the endothermic character of the substance. The critical temperature is −5° C. No evidence whatever of the existence of higher polymers of oxygen was obtained: both in the liquid and gaseous states the formula is O_3. This work is of great interest, and, apart from the determination of the physical properties of ozone, it removes the last doubt as to the simple character of ozone—"oxozon" does not exist.

DIFFERENTIAL GAS ANALYSIS.—Mention has already been made in NATURE of a method devised by Dr. G. A. Shakespear of Birmingham University for measuring differences in composition of similar gas mixtures. The method, which has proved itself valuable for controlling the purity of hydrogen, the safety of atmospheres in balloon sheds, and many other purposes, depends on the differences of thermal conductivity of gases. Two identical spirals of platinum wire are enclosed in separate cells in a metal block, each spiral forming one arm of a Wheatstone Bridge circuit, the other two arms being of manganin. An electric current flowing through the bridge thereby heats the two spirals, which lose heat to the walls of the cells. If the two cells contain gases of different thermal conductivities the spirals will cool at different rates, and one spiral will therefore be maintained at a higher temperature than the other. The difference in temperature of the two wires thus causes a deflection of the galvanometer, the extent of which depends on the difference in conductivity of the two gases. The construction is such that changes in the temperature of the gases affect both sides of the bridge equally. If, therefore, one cell contains a pure gas, and the other cell the same gas mixed with some other constituent, the extent of the deflection will indicate the proportion of the second gas present, and the galvanometer can be calibrated to show directly the percentage composition of the mixture. The difference in conductivity between air and carbon dioxide enables the method to be used to determine the percentage of carbon dioxide in flue-gases. The other constituents of flue-gases either have thermal conductivities differing but little from those of nitrogen, or are negligible in amount, while the effect of the water vapour can be counteracted by keeping the gases in both cells saturated. By attention to certain details the method may be then applied to follow the change in carbon dioxide content of the flue-gases in fuel-consuming installations. The instrument is made by the Cambridge Scientific Instrument Company.

The Origin of Magnetism.

WHEN the proposal was first made to hold in Section A of the British Association at Hull this year a discussion on "The Origin of Magnetism," it was met with the criticism from eminent quarters that the time was not yet ripe for the consideration of this subject. Those who attended the meeting will probably agree that this view was justified, for it can scarcely be said that the position was advanced appreciably, or that any real, or even plausible, answer was given to the main question involved. Perhaps this was in some measure due to the regrettable absence of Prof. Langevin, who had promised to make the opening remarks, and had expressed his intention of using the opportunity for a critical survey of the whole subject. But a recurrence of the ill-health from which he has intermittently suffered for a long time deprived the Section of Prof. Langevin's presence and his eagerly anticipated contribution to the discussion. As it was, the discussion lacked co-ordination; the remarks of the various speakers bore little relation to one another. There was the exposition by Prof. Weiss of his theory of the molecular field and the existence of magnetons; then Sir J. A. Ewing's description of his new molecular magnet models; then the remarks of Dr. A. E. Oxley on the changes of susceptibility imparted to platinum and palladium by the occlusion of hydrogen; and, finally, an account by Mr. L. F. Bates of the measurements of the Richardson effect recently carried out by Dr. Chattock and himself,—all contributions of considerable individual interest, but not closely related to one another nor providing an answer to the essential question of the *origin* of magnetism.

In spite of the comparative failure of the discussion in its wider aspects, one felt that the time had not been wasted, principally because it afforded an opportunity for Prof. Weiss to give a most interesting account of his work in connexion with ferromagnetism and paramagnetism, which is not too well known in this country. Prof. Weiss at very short notice undertook to open the discussion in place of Prof. Langevin, and a fairly complete account of his remarks will eventually appear in the Report of the Association. An outline of this exposition may be profitable here.

Starting from the analogy of the difference between the laws of fluid compressibility for low and high densities, Prof. Weiss showed how Langevin's kinetic theory of paramagnetic substances may be modified so as to include strong magnetism—or ferromagnetism—by the assumption of the existence of a *molecular field* analogous to van der Waal's internal pressure in fluids. A whole array of experimental facts was brought forward in support of this theory of the molecular field. It provides an explanation of the variation of magnetic saturation with temperature; it accounts precisely for the transformation of ferromagnetism to paramagnetism at the temperature of the Curie point, and for the observed law of this paramagnetism. The theory also points to a discontinuity of specific heat at the Curie point, and the magnitude of the discontinuity, calculated from magnetic data, agrees with calorimetric measurements. Still more interesting is the recently discovered magneto-caloric phenomenon, which consists of a reversible temperature variation accompanying magnetisation. This differs from the ordinary hysteresis effect, which is irreversible, and always involves heating. In the reversible effect, magnetisation produces a rise of temperature and demagnetisation a fall. At the Curie point the change is by no means negligible, reaching, as it does, a value of about 1° in fields readily attainable. The extent of temperature variation calculated by means of the molecular field theory agrees with that observed.

When one comes to calculate from various experimental data the numerical value of the molecular field, it proves to be of the order of magnitude 10^7 gauss, which is far in excess of the magnetic field which might in the most favourable circumstances be produced by the magnetic moments of the molecules of a ferromagnetic body, namely, 10^4 gauss. This remarkable result indicates that the so-called molecular field has not itself a magnetic origin. In this connexion Prof. Weiss's own (translated) words are worth quoting:—

"It is therefore impossible for the mutual actions represented by the molecular field to be of a magnetic nature. It is just a notation for forces of a non-magnetic character, with a symbol borrowed from magnetism. I prefer, in place of the primitive definition given earlier, the equivalent definition

$$H_m = -\frac{\delta U}{\delta I},$$

where U is the intrinsic energy per unit volume, and I the intensity of magnetisation. This definition is advantageous in that it does not prejudge the nature of the forces. . . . It does not appear to be impossible that the forces may be electrostatic; that, however, is at present a pure supposition."

In the second part of his address Prof. Weiss directed attention to another important aspect of the combined kinetic theory of Langevin and his own theory of the molecular field. The possession of these theories permits the calculation of the values of the molecular or atomic magnetic moments which have been the underlying assumption in all theories of magnetism. A great number of atomic moments have thus been evaluated from many experimental sources, such as the measurement of the magnetisation of ferromagnetic substances and their alloys both in the neighbourhood of absolute zero and above the Curie point, the investigation of the paramagnetism of solutions of salts, and the like. The general law which emerges is that "all atomic moments are integral multiples of the same elementary moment, to which the name *magneton* has been given." For example, six different and independent observers have found for nickel, over a temperature interval of about 400°, 8·03, 7·99, 8·04, 8·05, 8·03 and 7·98 magnetons respectively, numbers which, it will be seen, are in the immediate neighbourhood of the integer 8. It is, besides, a general property of atoms to possess different integral numbers of magnetons according to various conditions, such as their state of chemical combination, or their temperature, whether in the ion, or in the undissociated molecule. Prof. Weiss affirms that the magneton is a real entity, and he pointed to the fact that the Rutherford-Bohr atom, together with Planck's quantum theory, actually does indicate the existence of a universal elementary magnetic moment, which, however, proves upon calculation to be almost exactly five times as great as the magneton.

Prof. Weiss's general conclusions may be summed up by quoting him again:—

"1. One of the essential conditions for the production of strong magnetism—or ferromagnetism—is the existence, between molecules possessing magnetic moments, of important mutual actions which are numerically expressed by the molecular field, and are certainly of a non-magnetic nature.

"2. The appearance of atomic moments as integral multiples of the same elementary moment—the magneton—is thus one of the important aspects of magnetic phenomena."

Altogether a convincing exposition, in spite of Sir Ernest Rutherford's amusing allusion to the fascination which *whole numbers* have for physicists.

A. O. RANKINE.

Man and the Ice Age.

OF the many discussions which took place during the recent meeting of the British Association at Hull, few are likely, on purely scientific grounds, to prove of more importance than that on the relation of man to the ice age in Britain, in which the sections of geology, geography, and anthropology took part. It cannot be said that any agreement was reached; but the significance of the discussion lies in the fact that protagonists of different schools of thought in geology were brought face to face, while archæologists and geographers were able to formulate and lay before them problems for the solution of which they await the assistance of geologists. In considering the problems of the ice age, geologists and archæologists are dealing with the same material, but each from their special point of view. The result has been a difference in nomenclature and method of classification: the geologist thinks in terms of the deposits; the archæologist in terms of the artefacts found in them. Consequently, as Prof. P. F. Kendall pointed out, any discussion between them is likely to come to a deadlock through disparity of nomenclature. This discussion, however, showed that the difficulty is by no means insuperable.

It was apparent at an early stage in the discussion that there existed a clear-cut difference of opinion as to the method of approach in attacking the problem. Indeed the title of the discussion, in suggesting a restriction of the subject matter to Britain, was a challenge which Prof. W. J. Sollas was not slow to take up, when at the outset he maintained that it was impossible to consider the evidence in Britain apart from conditions on the Continent. Prof. Kendall, on the other hand, held that not merely must consideration be confined to the evidence as it is presented in the British area alone, but that the solution of the problem must be sought in East Anglia in the relation of the northern drift to the chalky boulder clay. On this point, Prof. Kendall's lucid summary of the evidence gave his audience a clear indication of the nature of the problem and of the extent to which the British data may be expected to throw light upon the problem as a whole. It turns to a great extent upon the view which is taken of the relation of the glacial deposits of Yorkshire to those of East Anglia. The chalky boulder clay of East Anglia was carried down by ice from north of the Wash and the fens. In Yorkshire there is a clear glacial sequence of at least three boulder clays, in the lowest of which is a Scandinavian element. In Prof. Kendall's opinion the hope of correlating the Yorkshire evidence with that of East Anglia is to be found in the Wolds, on the west of which is found the purple clay of Yorkshire, and on the east, the chalky boulder clay. Was it possible, he asked, that the latter might be the purple clay transformed by its passage over the Wolds?

The trend of the discussion was to show that the archæological problem is narrowing down to the question of the relation of the gravels containing Chellean and Acheulean implements to the boulder clay, a definite issue for solution by excavation. At Hoxne, such implementiferous gravels were found to overlie a boulder clay, but the evidence is by no means entirely conclusive and appears to conflict with that from elsewhere. Prof. Boswell had hoped to be in a position to place before the sections the results of excavations undertaken to determine this point, but, unfortunately, they had not been completed in time. On the other hand, Mr. Hazzledine Warren showed himself an uncompromising opponent of anything but a post-glacial date for the palæolithic gravels, on the ground that they are conformable to the holocene alluvium, a condition which would be impossible had they been subjected to glacial action. The general disposition appeared to be, however, that further evidence on this clear crucial point must be awaited. On the whole, this would appear to be in agreement with the tendency of the opinions which have been elicited by the British Association Committee appointed at the Cardiff meeting to report on the relation of early types of palæolithic implements and glacial deposits. Of these some have appeared in *Man*; others await publication.

The interest of archæologists and geographers, however, is not bounded by the position of man in relation to glacial deposits in this country. They would wish to know how far conditions in this country can be equated with conditions in the Continental area, extending this term to include North Africa, and how far it is possible by geological evidence to link up the palæolithic cultures of this country with the cultures of these areas. They welcomed, therefore, the opening remarks of the president of the anthropological section, Mr. Peake, in which he referred to the tentative scheme for effecting this which he had put forward,[1] and the pronouncement of Prof. Sollas that the British evidence could not be considered apart from the Continental evidence. Prof. Sollas ably summarised Penck's views, and pointed out how the differences between the French and German geologists might be reconciled—differences however, which did not affect the question of the geological age of man. Penck's four great periods of glaciation in the Eastern Alps could be correlated with the river gravels, while in France glaciation could be brought into relation with raised beaches. As a result of such a correlation, it appeared that the Chellean implements belonged to a warm period, the Riss-Würm, the Mousterian straddled the Würm, and the Aurignacian and later phases of palæolithic culture were post-Würm.

The point of view of the archæologist and geographer was well put by Prof. H. J. Fleure. The archæologist in particular has arrived at certain conclusions on purely archæological evidence, for which he looks to the geologist for confirmation or the reverse. Prof. Fleure pointed out that the three centres of glaciation, Scandinavia, Britain, and the Alps, could not be considered apart. Any change in the distribution of ice in one area was bound to affect the climate and distribution of ice in the others. It was therefore incumbent upon the geologists to produce a scheme applicable to all areas.

An interesting question to which Prof. Fleure alluded is raised in the relation of the Bühl period, which was marked by a readvance of the ice, to the conditions in Scandinavia described by de Geer. The study of climatic conditions may also be expected to throw light upon the problem. Prof. Fleure pointed out that a constant anticyclone over the

[1] *Man*, 1922, No. 5.

glaciated region would cause a constant succession of cyclones accompanied by a high rainfall over the Mediterranean and Western Asia. This would support the view that the desert belt of the Sahara was then more to the south, thus accounting for the vast number of palæolithic implements, accompanied by ostrich shells, found in that area. It would also strengthen the probability that man drifted north as the climate improved after the Würm period, and confirm the suggestion of the archæological evidence that after the Aurignacian period there is no break.

A series of recent investigations on the south coast in Hampshire and Sussex, which were described by Dr. L. S. Palmer, bear very directly upon the question of the equation with Continental deposits. Dr. Palmer, who worked in collaboration with a geologist, had endeavoured to relate climate and deposits with implements. As a result, the 100 ft. terraces and beaches show a warm fauna associated with Acheulean and early Mousterian implements; the 50 ft. and 15 ft. terraces a cold fauna associated with Mousterian implements, the cold period being interrupted by a slightly warmer period which justified the division of this phase into two parts. In the superficial brick earths were the Aurignacian, and over the latest Combe rock were the Magdalenian implements. Dr. Palmer found a correspondence between climate, culture, and land oscillations. The investigations were carried out without reference to nomenclature, but on comparison, corresponded with the Continental system of Penck.

At this point the discussion closed. If it had attained no very definite conclusion, the air had been cleared. One definite question has been formulated for further investigation, and it has been shown that a considerable body of opinion is approaching some kind of an agreement as to the manner in which the evidence in Britain may be brought into relation with that of the Continent.

Generation and Utilisation of Cold.

THE general discussion on the generation and utilisation of cold which was held at the Institution of Electrical Engineers on October 16 was organised jointly by the Faraday Society and the British Cold Storage and Ice Association.

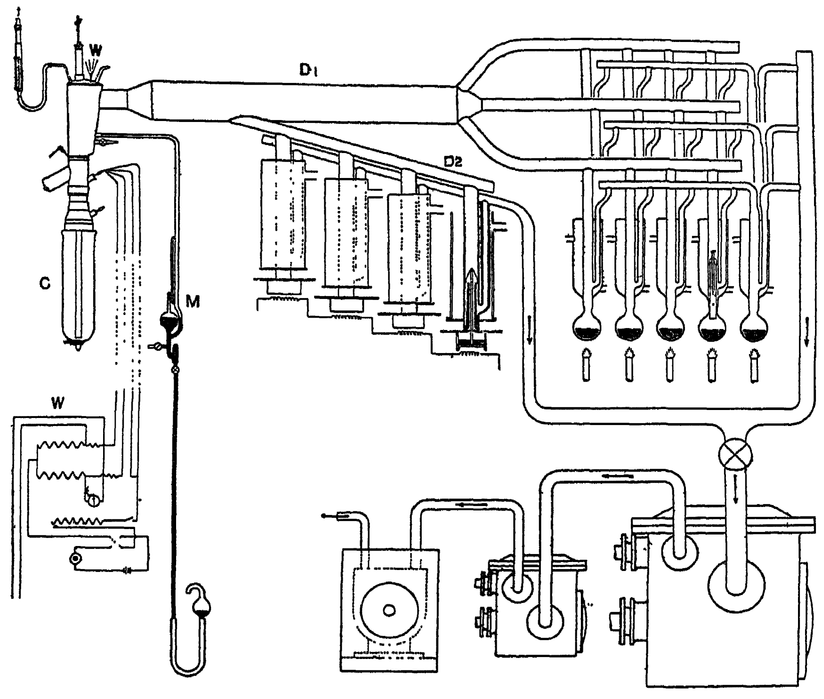

FIG. 1.—Apparatus used in attempt to solidify helium.
C, helium cryostat; M, McLeod gauge; W, resistance manometers; D_1, connexion to glass Langmuir pumps; D_2, connexion to iron Langmuir pumps.

Although the papers read at the meeting dealt with various aspects of the liquefaction of gases, there were no contributions from the refrigerating industry. Possibly the applications of cold for the preservation of food stuffs have become so standardised that our refrigerating engineers do not interest themselves in new developments. It was intended that the opening paper of the discussion should be read by Prof. H. Kamerlingh Onnes, but owing to the death of his colleague, Prof. Kuenen, he was unable to be present. Consequently Dr. C. A. Crommelin communicated Prof. Onnes's paper as well as his own.

The Leyden cryogenic laboratory has been engaged on low-temperature investigations for the past thirty-five years, and such magnificent work has been done there that any communication emanating from this specialised institution is read with considerable interest.

Dr. Crommelin's paper was of the nature of a general description of the methods of experiment whereby they obtained any desired temperature below zero centigrade and maintained this temperature constant within 0·01° C. The equipment of the cryogenic laboratory is essentially a series of plants working on regenerative Pictet cycles down to liquid nitrogen temperatures. Below this, liquid hydrogen and liquid helium are employed. In the Pictet cycles methyl chloride, nitrous oxide, ethylene, methane, oxygen, and nitrogen are used. Any one of the substances boiling under appropriate pressure will give a range of steady temperatures. By these means a range from −24° C. to −270° C. is obtained which is complete but for short gaps.

Cryostats containing the different liquids are thermally insulated by vacuum walled vessels and the losses reduced to a minimum by the immersion of the apparatus in baths of the commoner elements such as liquid oxygen.

For the range −259° to −269° C., which cannot be obtained by the use of a boiling liquid, a hydrogen vapour cryostat is employed, the vapour being heated electrically to the desired temperature and circulated around the experimental bulb.

The paper also contains some interesting data as to the capacity of the plant, and it is stated that liquid hydrogen can be produced at the rate of more than 13 litres per hour. A high degree of purity is required in the gases employed, and it appears that

the ordinary liquid air process of producing oxygen does not give gas of sufficient purity.

Prof. Onnes's paper contains an account of his attempts at producing solid helium and, of course, the attainment of the lowest temperature. His original experiments with helium date back to fifteen years ago, when he found that liquid helium boiling under the lowest pressure he could produce (about 2·2 mm.) did not solidify. The temperature was estimated as 1·15° absolute. In 1920, Onnes determined to make a fresh attempt, using the best pumps available for reducing the pressure. Batteries of Langmuir condensation pumps were constructed, twelve of glass and six of iron, all working in parallel and delivering into two Burckhardt vacuum pumps connected in series with a Siemens oil pump. The largest Burckhardt pump was capable of dealing with 360 cubic metres of gas per hour. A diagram of the experimental arrangements is shown in Fig. 1.

The complete battery of pumps was capable of removing one litre (N.T.P.) of gas per hour under a suction pressure of 0·005 mm., but owing to the gas friction in the apparatus, the actual pressure produced at the surface of the helium was only 0·012 to 0·014 mm. Under these conditions the lowest temperature attained was 0·82° absolute. Even then helium did not solidify.

Not the least difficult part of these investigations is the measurement of temperature. The actual temperature of the liquid is obtained by calculations based upon the general equation of Van der Waal and extrapolating the temperature vapour pressure relationship for helium. The form of the extrapolated curve was compared with those obtained for various other elements as the line shows a decided curvature at normal temperatures. At the meeting Prof. Porter discussed the theoretical basis of this method of extrapolation and the possible error.

The two papers from the Leyden laboratory should prove of material assistance to the student interested in the technique of low-temperature investigations.

The industrial application of the liquefaction processes was dealt with by three speakers. Mr. K. S. Murray gave a general account of the processes employed by the British Oxygen Co. It was interesting to hear that the efficiency of the liquefaction process is not appreciably greater than that of the old barium oxide process using the reversible pressure reaction. The advantage of the liquefaction process is that it produces a purer gas. Figures for the cost of producing oxygen were given, as well as technical descriptions of the various types of rectification apparatus.

The second paper was sent by M. Claude, and in it was described a plant for the separation of hydrogen from water gas by a liquefaction process. The method can be utilised when the gas, such as that from coke ovens, is too impure to permit of the use of the catalytic reaction depending upon the conversion of carbon monoxide to carbon dioxide. The plant described is used for supplying hydrogen to a synthetic ammonia apparatus producing 5 tons of ammonia per day. An interesting feature of the apparatus is the introduction of small amounts of nitrogen into the system to serve as liquid nitrogen lubricant in the expansion engine.

In the third paper, Mr. E. A. Griffiths gave an account of the use of oxygen in breathing apparatus for airmen, and also of the plants for manufacturing liquid oxygen for this purpose. The chief difficulty in the use of cold liquefied oxygen is that of storage and transport. The mechanism of the metal vacuum vessel, which is the only practicable solution of the problem, was briefly dealt with. The manufacture of these vessels is a simple matter, and the thermal losses in properly constructed vessels is 12 per cent. of the liquid oxygen content per day for a flask of two litres capacity, while for a twenty-five-litre flask it is only 4½ per cent.

The vaporisers for converting the liquid oxygen into gas at a rate which can be kept under control were described. In view of the simplicity of these devices, it is surprising that greater use is not made of liquid oxygen in medical and experimental work.

The portable plants employed for producing oxygen utilise both the Claude and the Linde principles. Although the theoretical efficiency of expansion with external work is about three times that possible with the Joule-Thomson free expansion, the actual results obtained on test are not appreciably different. This appears to be due to the practical limitations of the expansion engine. A similar conclusion was arrived at independently by Mr. Murray in the case of large plants.

The expenditure of power for the production of oxygen is of the order of 2½ to 3 H.P. per litre/hour: the figure for the Pictet cycle, according to Crommelin, is decidedly lower, being only 1·64 H.P. per litre/hour. The over-all efficiency of liquefaction processes is therefore extremely low and generally less than 3 per cent.

The remaining papers were contributed by investigators working under the direction of the Engineering Committee of the Food Investigation Board (Department of Scientific and Industrial Research).

Dr. Ezer Griffiths dealt with the determination of thermometric lag in various types of thermometers and with some new materials for thermal insulation at low temperatures.

Prof. C. F. Jenkins gave a summary of his work on the thermal properties of ethyl chloride. His research on this substance is an extension of his previous work on carbon dioxide. The data which he has now obtained should be of considerable value to the refrigerating engineer, for ethyl chloride has many advantages over ammonia and carbon dioxide for use in small refrigerating plants.

E. A. GRIFFITHS.

Propagation of the Sound of Explosions.

IT has frequently been noted that on the occasion of great explosions there are curious anomalies in the propagation of the sound. Usually there is a normal zone of audibility in the immediate neighbourhood of the explosion, beyond this a zone of silence, where the sound is not heard, and again outside the zone of silence a second zone of audibility. It is remarkable that while an observer at say 50 miles away may not hear an explosion, an observer at 80 miles may hear it distinctly.

These abnormalities are closely connected with the meteorological conditions, though the detailed relationship between them is not known. One theory is that the wind lifts the sound over an area and brings it down again many miles away. Another theory ascribes the zone of silence to the effect of the distribution of wind and temperature at high altitudes. The theoretical development of the problem is extremely complex, and so it was decided to make an experimental study of the meteorological conditions along with detailed observations of the extent of the zone of silence in the hope of elucidating the relationship between them.

The International Commission for the Investigation

of the Upper Air appointed a sub-commission to consider the problem set out above, and the sub-commission applied to various Ministries of War with the view of obtaining their collaboration in the case of obligatory destruction of explosives. The first favourable reply came from the Dutch Ministry of War, and it was finally arranged that at 17h. G.M.T. on October 28, five tons of ammonium perchlorate should be exploded on the Oldebroek Artillery Drill Ground (longitude 5° 59′ 40″; latitude 52° 29′ 56″).

In this country arrangements were made by the Meteorological Office for the observers at all the observatories and reporting stations to listen for the sound, and to make notes regarding the meteorological conditions at the time. Where possible, observations of wind and temperature in the upper air were also made. In addition, through the medium of the Press, the public were also invited to forward to the Meteorological Office notes of any observations made.

Up to the time of going to press a total of more than one hundred reports have been received and it has not yet been possible to examine them in detail. The most distant points at which the explosion is alleged to have been heard are North Wales and Northumberland. Two valuable records have been obtained on the hot wire microphones of the Signals Experimental Establishment, at Woolwich, and at Biggin Hill (Kent) respectively.

As soon as the British observations have been examined and summarised, the results will be forwarded to the Dutch Meteorological Service for collation with continental reports.

The Whitworth Scholarships.

SEVERAL important changes are indicated in the new regulations for Whitworth Scholarships which have been issued by the Board of Education. In 1923 six Whitworth Scholarships, each of an annual value of 125*l*. and tenable for three years, will be offered for competition, as well as two Whitworth Senior Scholarships of an annual value of 250*l*., tenable for two years. There are also Whitworth prizes which will be awarded to unsuccessful competitors for the scholarships, not exceeding 25 in number and of value 10*l*. each. The Whitworth Exhibitions (50*l*. tenable for one year) have been abandoned. The scholarships will be open to candidates whose age does not exceed 21 years, and the number of subjects in which candidates will be examined is limited to four. Candidates for the senior scholarships must be less than 26 years of age and will be examined in seven subjects.

The Board has also issued a circular directing attention to the changes, some of which were made last year, in order to render the requirements regarding candidates' practical experience in handicraft more consistent with the present arrangements for apprenticeship and training in mechanical engineering. The Board's experience shows that candidates may be divided into two groups, a large one consisting of candidates whose education since leaving school has been part-time, and for whom a full-time course of study is likely to be suitable, and a smaller one consisting of those who have already completed a full-time course and can take a further course of work of post-graduate standard. Hence the institution of scholarships and senior scholarships.

There still remain difficulties which the new regulations will not remove. In the four years between 17 and 21 years of age a hard-working evening student can reach the ordinary university degree standard in the subjects laid down for the scholarship examinations, but has only touched lightly certain subjects which form part of any organised full-time course. If a scholarship is awarded to him, and he proceeds to a full-time course, he will find that he cannot be exempted from repeating a great deal with which he is perfectly familiar. This difficulty is a very real one, as is well known to every teacher who has been consulted by a successful Whitworth candidate regarding his choice of a suitable college. There is also the difficulty of finding a suitable opening in the works after having been away for three years between the ages of 21 and 24, a difficulty which has led to many promising young men abandoning practical life in favour of teaching.

The circulars issued by the Board convey the impression that they do not favour the plan followed by many of the former scholars, who spent their scholarship term in works offering special facilities for widening their practical experience, and at the same time continued their studies in part-time courses. There is a great deal to be said in favour of this plan, and a glance at the names of former scholars who followed it and have risen to eminence in engineering would appear to justify its reconsideration.

University and Educational Intelligence.

BRISTOL.—The Bristol Medico-Chirurgical Society has offered the society's library as a gift to the University. The library comprises about 15,000 volumes (some rare and of great interest) and has been valued at more than 12,000*l*. It contains some rare books and receives more than 100 current periodicals in exchange for the society's journal. The council of the University has very gratefully accepted this magnificent offer, which will raise the medical library of the University to one of the most valuable medical libraries in the country. The advantage to the research worker of having access to such a library cannot be over-estimated.

CAMBRIDGE.—Mr. R. E. Priestley, Christ's College, has been elected to a fellowship at Clare College; Mr. M. C. Johnson, St. John's College, has been elected to the Arnold Gerstenberg studentship; Mr. N. J. T. M. Needham, Gonville and Caius College, has been elected to the Benn W. Levy research studentship in biochemistry.

The Syndicate appointed to draft Ordinances to carry out the provisions of the new statute admitting women students to the titles of degrees has been published. It is proposed to recognise Girton and Newnham Colleges as institutions for the higher education of women for the purposes of the statute. The total number of students at the two colleges (or at all institutions for the higher education of women, should any fresh college be recognised) who are receiving instruction in the University or working in the University laboratories or museums is not to exceed five hundred. The Council of the Senate may at any time inquire into the condition and management of a recognised institution for the higher education of women, and may, if it think fit, recommend the termination of its recognition. Women must reside nine terms, and in other such matters come under the same regulations as the undergraduates before admission to the titles of their degrees. Once the title has been conferred upon them, they become entitled to wear the same academical dress as that worn by a member of the University who has been admitted to the same degree. Women are to be admitted to courses of research and to examinations for diplomas sub-

stantially on the same terms as men. Residence already kept and examinations already passed will qualify past students for the same privileges as if the new regulations had been in force in earlier days.

The *Times* announces a bequest by the late Mr. A. M. Shield of some 90,000*l.* to the Cambridge Medical School. The only definite item mentioned is the foundation of a Marmaduke Shield scholarship of 100*l.* a year in human anatomy.

LEEDS.—The following appointments to the staff have been made by the Council of the University: Mr. R. B. Tasker, honorary demonstrator in anatomy for dental students; Mr. C. Holland Child, Mr. G. H. H. Russell, and Mr. R. B. Tasker, honorary clinical tutors in dental surgery; Dr. A. C. Monkhouse, research assistant in the fuel industries department, to work under the joint committee of the Institution of Gas Engineers and the University on gas heating, lighting and ventilation research; Dr. E. C. Porter, demonstrator in the department of leather industries; Mr. J. C. Mann, assistant lecturer in agricultural chemistry; Mr. S. J. Saint, assistant lecturer in agriculture; Mr. R. E. Edwards, demonstrator in agricultural botany; Mr. J. C. Leslie, district lecturer in agriculture; Mr. G. F. Pilling, assistant lecturer and demonstrator in agriculture; Mr. H. W. Swift, demonstrator in engineering; Mr. W. A. Wightman, demonstrator in organic chemistry; Mr. Thomas Henderson, demonstrator in inorganic chemistry; and Miss E. M. Hickman, demonstrator in the department of pathology and bacteriology.

MANCHESTER.—Applications are invited for the position of Keeper of the Museum in place of Dr. W. M. Tattersall, now of the University College of South Wales, Cardiff. The latest date for the receipt of applications, which should be sent to the Secretary of the Manchester Museum, is Friday, December 1.

Provision has been made in the Faculty of Technology, which formerly awarded an ordinary degree of B.Sc.Tech., to give a higher B.Sc.Tech. degree in various sections of technological science, one of which will be the chemistry of colouring matters.

In view of the retirement of Prof. H. B. Dixon from the chair of chemistry, a committee of past and present students are raising a fund to recognise his thirty-five years of distinguished service. The fund is to be devoted mainly to the provision of grants to enable students of chemistry to complete their courses, and it is also intended to set up in the chemical theatre a plaque or bust of Prof. Dixon. These objects necessitate a generous response on the part of old students and colleagues of Prof. Dixon, and those who have not yet subscribed are invited to send their subscriptions to Dr. Norman Smith at the University. A complimentary dinner will be held on December 8, further particulars of which can be obtained from Dr. J. E. Myers.

THE Association of Science Teachers and Association of University Women Teachers have organised a conference on the teaching of science in schools and colleges to be held on Saturday, November 25, at University College, London. The opening speakers will be Sir William Tilden and Mr. A. G. Tansley.

THE Parliamentary candidates of University constituencies, for the general election on November 15, are as follows (the names of new candidates are in italics):—Oxford (2).—Lord Hugh Cecil (U.); Sir Charles Oman (U.). Cambridge (2).—J. F. P. Rawlinson (U.); *Prof. W. R. Sorley* (U.); *J. R. M. Butler* (Ind.). London.—*Sir Sydney Russell-Wells* (U.); *Prof. A. F. Pollard* (L.); *H. G. Wells* (Lab.). Combined English (Manchester, Liverpool, Durham, Leeds, Sheffield, Birmingham, and Bristol) (2).—H. A. L. Fisher (N.L.); Sir Martin Conway (U.); *B. Faraday* and *Dr. S. Lawrence* (U.), and *L. Woolf* (Lab.). Wales.—*Sir E. J. Ellis Griffith* (L.); *T. A. Lewis* (N.L.). Scotland (St. Andrews, Glasgow, Aberdeen, and Edinburgh) (3).—Sir Henry Craik (U.); *Sir George Berry* (U.); D. M'Coig Cowan (N.L.). Queen's, Belfast.—Sir William Whitla (U.).

THE list of successful candidates in the open competition for Royal Scholarships and Free Studentships, 1922, just issued by the Board of Education, shows that in Group A (Mechanics) there were fifty-four competitors, and of the nine scholarships and studentships awarded, six are to apprentices in H.M. Dockyard. This is a remarkable testimony to the efficient educational work carried on in the dockyard schools, which all dockyard apprentices must attend for certain specified periods every week. The number of competitors in the other groups of subjects in which scholarships and studentships are awarded were: physics, 17; chemistry, 16; biology, 1; geology, no qualified candidates.

NUMEROUS announcements of courses of technical education for 1922–23 have been received recently. Courses of advanced study and training in research are offered by the Manchester College of Technology in many branches of applied science, including special problems connected with textiles, brewing and allied industries, paper-manufacture, photography, coal-tar, dyestuffs, and india-rubber. The college awards annually a varying number of research scholarships (last year twelve) of 100*l.* each, open to graduates of any university in the British Empire and to other persons suitably qualified. A department of industrial administration has recently been opened. The Sir John Cass Technical Institute of Aldgate, London, invites special attention to its advanced courses (evening) in brewing, micro-biology, petroleum technology, colloids, alternating currents and electrical oscillations, metallography and pyrometry, heat treatment and mechanical testing of metals and alloys, and foundry practice. The Northampton Polytechnic of Clerkenwell, London, has, in addition to its evening courses, day courses in civil, mechanical, including automobile and aeronautical, and electrical engineering, in optical engineering and applied optics, and in horology.

THE Scottish Colleges of Agriculture maintain a close connexion with the regions which they serve by means of their systems of extra-mural work, including lectures and individual instruction, demonstrations and experiments, and advisory work. The Calendar for 1922–23 of the Edinburgh and East of Scotland College mentions a notable development of work in connexion with school gardens which have been laid down under the guidance of the college staff at 196 schools. Seven supplementary school centres are visited by the staff once a week for practical instruction in the school garden combined with theoretical instruction in the laboratory. The Calendar of the North of Scotland College contains an account of the recently opened Rowett Institute for research in animal nutrition, and of an important research which is being conducted by Dr. Rennie in regard to certain diseases of adult bees. In the area served by this college, attendances at county extension classes increased during the past two years from three to eighteen thousand, while attendances at short courses of lectures and single lectures increased from fifteen to thirty-eight thousand. Special schemes are arranged to meet the requirements of the crofting districts in the western seaboard and islands and in Shetland.

Calendar of Industrial Pioneers.

November 5, 1800. Jesse Ramsden died.—Called by Delambre "le plus grand de tous les artistes," Ramsden, by the combination of great scientific ability and practical skill, rose to be the leading instrument maker of his day. Especially valuable was his invention of a dividing machine completed in 1773 after ten years' work. He was born in Halifax, Yorkshire, in 1735, worked first as a cloth worker, and then learned the art of engraving from a London optician.

November 6, 1913. Sir William Henry Preece died.—Born in Carnarvon in 1834, Preece, after passing through King's College, London, joined the Electric and International Telegraph Company and eventually became one of the principal telegraph engineers in the country. From 1892 to 1899 he was Engineer-in-Chief and electrician to the Post Office, in which situation he made some of the earliest experiments in wireless signalling and gave valuable support to Marconi. He was twice president of the Institution of Electrical Engineers and was also president of the Institution of Civil Engineers.

November 8, 1807. Pierre Alexander Laurent Forfait died.—A distinguished naval constructor whose skill proved of the highest value to the French nation, Forfait first gained a reputation by the building of sailing-vessels for maintaining regular communication between France and America. He was the author of a treatise on the masting of ships and wrote many papers for the Paris Academy of Sciences and the "Encyclopédie Méthodique." He carried out important work at Antwerp and on the Seine, and under Napoleon served in the Ministry of Marine.

November 8, 1911. William Edward Ayrton died.—The author of some 150 scientific papers, a prolific inventor, and one of the pioneers of technical education in London, Ayrton served in the Indian Telegraph Service from 1868 to 1872, was professor of physics and telegraphy at the Imperial Engineering College, Tokio, and from 1884 held the chair of physics and electrical engineering at the Central Technical Institution, London. His researches extended to all sides of modern electrical engineering, while among the positions he filled were the presidencies of the Physical Society and the Institution of Electrical Engineers.

November 11, 1906. John Devonshire Ellis died.—Trained as an engineer at Birmingham by his father, Ellis in 1854 joined John Brown at the famous Atlas Works at Sheffield, with which he remained connected till his death. He was largely responsible for the manufacture of the armour for our first ironclads, the *Black Prince* and *Warrior*, and was an ardent advocate of the Bessemer process of making steel. He also introduced a method of welding a hard steel face to a wrought-iron backing for the armour of ships. He succeeded Brown as head of the firm in 1870, and in 1889 received the Bessemer medal of the Iron and Steel Institute.

November 11, 1893. Anthony Reckenzaun died.—A pioneer of electric traction, Reckenzaun was born at Gratz, Styria, in 1850, and, after being trained as an engineer, worked in England and was engineer to the Electric Power Company. In 1881 he made a trial of an electric car, in 1882 built the launch *Electricity*, and in September 13, 1886, with the *Volta* crossed the Channel, the motive power being obtained from electric cells. He also visited America and applied his system of driving by electric batteries to some cars at Philadelphia. E. C. S.

Societies and Academies.

LONDON.

Association of Economic Biologists, October 13.—Prof. E. B. Poulton, president, in the chair.—E. J. **Butler**: Virus diseases in plants. The first demonstration that disease can be caused by a filtrable virus was by Iwanowski, in 1892, in mosaic disease of tobacco. Mosaic is now known in nearly 100 species of plants. Diseases like peach-yellows and others characterised by phloem-necrosis are probably caused by similar agents though the filtered juice is not infective. All hitherto tested can be transmitted by grafting, most of them by insects (the chief method in Nature), and many by inoculating with sap. Contact will not cause infection. Infection may be hereditary in the insect transmitter and in the plant. "Carriers" are known. The causal agents are believed to be living organisms. Several investigators have recently found large amoebiform corpuscles or smaller granules in infected cells. The former have been compared with cytoryctes or neuroryctes and the latter with Chlamydozoa but a resemblance to Rickettsia is suggested. The causal organisms appear to be obligate parasites.—J. A. **Arkwright**: Virus diseases in animals and man. The chief points of interest common to plant and animal "virus diseases" are (1) the nature and properties of the virus; (2) the means of transmission, *e.g.* "carriers" and insect vectors; (3) measures for prevention, *e.g.* breeding or selection, and isolation or destruction; (4) perhaps the concentration of the virus in certain special tissue cells. About fifty animal virus diseases have been described which may be roughly classified as follows: (1) visible, not filtrable, not cultivated, *e.g.* Rickettsia; (2) probably visible, filtrable, cultivated, *e.g.* pleuro-pneumonia of cattle, poliomyelitis; (3) filtrable, not cultivated, some (?) visible in the tissues, *e.g.* foot and mouth disease, vaccinia; (4) filtrable, very resistant, *e.g.* infectious anæmia of horses, fowl-pox. In general properties most do not differ much from bacteria, though some are very resistant to drying, glycerine, and heat. The smallest clearly visible and the largest filtrable particles are of the same order of size, *i.e.* about 0·2 micron. Living organisms may conceivably be much smaller than this. The differentiation of colloidal particles of about 0·2 micron in size by means of the microscope requires attention especially to their arrangement and their range of size and shape, rather than to the appearance of individual particles. Theoretically it is possible that an enzyme may be the cause of an infectious disease on the analogy of Twort's lytic substance and the bacteriophage of d'Herelle.

PARIS.

Academy of Sciences, October 2.—M. Albin Haller in the chair.—H. **Deslandres**: The emission of X-rays, ultra X-rays, and corpuscular rays by the celestial bodies. A summary of previous results on radiations of high frequency and great penetration given by the sun and stars. These radiations form an extremely minute proportion of the total radiation, but their remarkable electrical properties give them an important rôle in the electrical phenomena of atmospheres. Kohlhörster's experiment on the ionisation of gas in a closed vessel at high altitudes (9000 metres) should be repeated at several points on the earth, and extended to the highest possible altitudes attainable by captive balloons. The cost will be considerable, and international co-operation is suggested as desirable.—A. **Brachet**: The properties of the germinal

localisations of the egg. The eggs of *Rana fusca*, after growth to the advanced blastula stage, were pricked with a needle at various points. From the resulting modifications in the growth it can be concluded that the formative materials of the whole of the central nervous system and the dorsal chord are, in the blastula and consequently in the fertilised egg, localised in the zone occupied by the grey crescent.—Paul **Montel**: Quasi-normal families of meromorphic functions.—Eligio **Perucca**: The surface properties of mercury: voltaic character, surface tension, photo-electric effect. Measurements of the Volta effect and surface tension of mercury in a vacuum and in different gases at varying pressures show changes in both magnitudes which are in qualitative agreement with the anti-contact theory of Frenkel.—Jean **Durand**: Contribution to the study of the thermal modifications of some cast irons. A diagram is given showing the volume expansions and contractions produced in a fragment of cast iron by five successive heatings between 600° C. and 900° C. The swelling of cast iron becomes significant only if the proportion of silicon is sufficiently high and the heating is slow.—L. J. **Simon** and A. J. A. **Guillaumin**: The quantitative determination of carbon and of hydrogen by the use of chromic and sulphuric acids. The carbon is determined directly as usual and the hydrogen indirectly by measuring the amount of oxygen (derived from a weighed amount of potassium bichromate) used in the combustion. Analytical figures are given for ten organic compounds of different types.—A. **Brives** and M. **Dalloni**: The earthquake of August 25, 1922, and the geological structure of the region of Ténès-Cavaignac (Algeria).—René **Souèges**: Embryogenic researches on *Hippuris vulgaris*.—Marc **Bridel** and Mlle. Marie **Braecke**: The presence of aucubine and of saccharose in the seeds of *Rhinanthus Crista-Galli*. The biochemical method of Bourquelot applied to Rhinanthus seeds indicated the presence of saccharose and aucubine, and both these substances were then isolated from the seeds in a pure state.—A. **Policard**: The mechanism of working of the adipose cells. The elaboration by the mitochondria represents only one of the possible modes of fixing fat; the adult cell takes up the fat by direct fixation without preliminary chemical change.—A. **Desgrez**, H. **Bierry**, and F. **Rathery**: Diabetes, β-oxybutyric acid, and levulose. A study of the conditions under which a certain quantity of levulose may be added with advantage to the diet of diabetic patients.—A. **Goris** and P. **Costy**: Urease and urea in fungi. Urease is present in nearly all the higher fungi. In cases where urease is absent, or present in very small proportion, urea has been found to be present.—Emile F. **Terroine**, R. **Wurmser** and J. **Montané**: The influence of the constitution of the nutritive media on the composition of *Aspergillus niger*.—Georges **Truffaut** and N. **Bezssonoff**: A new bacillus capable of fixing nitrogen. This organism was isolated from some cultures of Versailles garden soil, and morphologically is connected with the Proteus group. This bacillus is aerobic and fixes atmospheric nitrogen. It appears to differ from the bacilli assimilating nitrogen hitherto known, and it is proposed to name it *Bacillus Truffauti*.—J. **Cluzet**, A. **Rochaix**, and Th. **Kofman**: The action of the secondary radiation of X-rays upon micro-organisms.

October 9.—M. Albin Haller in the chair.—H. **Douvillé**: The Lepidocyclines and their evolution: a new genus "Amphilepidina."—E. L. **Bouvier**: New researches on the appearance of reproductive individuals in the ants, *Formica rufa*, and *F. pratensis*.—Paul **Vuillemin**: The petalostem.—G. **Bratu**: Progressions of higher order.—Halvor **Hansson**: A new method of multiplication of functional scales.—M. **d'Ocagne**: Remarks on the preceding communication.—Rodolphe **Soreau**: The laws of variation of the characteristics of standard air with altitude.—M. **Seigle**: The possibilities of the commercial use of mild steel bars hardened by extension. Details of the mechanical effects produced in mild steel bars by extension up to the breaking point have been given in an earlier communication. The advantages of this method of hardening are summarised and various possible industrial applications mentioned.—Charles **Nordmann** and M. **Le Morvan**: The effective temperatures of the stars θ and ι in the Great Bear. Reply to a criticism of Ejnar Hertzsprung on a previous communication.—Charles L. R. E. **Menges**: The coefficient of Fresnel.—G. **Holst** and F. **Oosterhuis**: The explosive potential of a gas. In Townsend's theory of ionisation by shocks the explosive potential depends only on the properties of the gas, and the material of the electrodes is without effect. The authors have proved experimentally that the nature of the cathode has an important influence. They support the hypothesis that the positive ions do not produce ionisation by contact with the gas molecules, but that by their electrostatic attraction they can liberate them from the cathode. A new theory of explosive potential is outlined, based on this hypothesis.—Jean **Rey**: The probability of illuminating an aeroplane by means of an electric projector.—André **Brochet**: Remarks on the preparation of cyclohexanol. Phenol containing 5 per cent. of its weight of reduced nickel as catalyst is readily reduced to cyclohexanol by hydrogen under pressure in an autoclave. The temperature should be maintained between 100° C. and 150° C. and the pressure kept at 10 to 15 atmospheres. The conversion is quantitative, and no indication was obtained of the formation of any intermediate compound.—A. **Damiens**: The absorption of ethylene by sulphuric acid. The production of ethyl alcohol, diethyl sulphate, and of liquid hydrocarbons. Cuprous oxide dissolved in the strong sulphuric acid proved the best catalyst. On hydrolysis, the acid solution gave different products with varying conditions. Absorption at ordinary temperature, with acid not under 97 per cent., gives ethyl alcohol only, but when a certain concentration of ethylsulphuric acid is reached, ethyl sulphate is also formed. At higher temperatures the velocity of absorption increases, and a considerable quantity of saturated hydrocarbon of the nature of petrol appears among the products of hydrolysis.—C. **Mariller** and Van **Ruymbeke**: A method for the preparation of commercial absolute alcohol and its application to the preparation of a national motor fuel. The vapours from 95 per cent. alcohol pass up a rectification column down which a stream of glycerol is descending. The latter removes water and the distillate contains 98·5-99 per cent. alcohol. The alcohol removed by the glycerol can be readily recovered.—Raoul **Combes** and Mlle. Denise **Kohler**: The disappearance of hydrocarbons in dying leaves. When the leaves die in the autumn, about 45 per cent. of the carbohydrates remain in the fallen leaf and are lost to the tree; 35 per cent. disappear by respiration and only 20 per cent. return to the living parts of the tree and are retained in a form ultimately utilisable.—St. **Jonesco**: The transformation of a chromogen of the yellow flowers of *Medicago falcata* under the action of an oxydase.—Marcel **Mirande**: The relation between anthocyanine and the oxidases.—Léon **Azoulay**: Provoked and spontaneous movements of the leaves of *Russula Queletii* and its varieties.—P. **Mathias**: The evolutive cycle of a holostomid

trematode (*Strigea tarda*).—M. Blanchard and G. Lefrou: A spirochæte found in the blood in a case of hæmoglobinuric bilious fever and its pathogenic action.

Diary of Societies.

MONDAY, NOVEMBER 6.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

SOCIETY OF ENGINEERS, INC. (at Geological Society), at 5.30.—E. E. Turner: The Atlantic Cruise of H.M. Airship R34.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—F. Gill and others: Discussion on The Importance of Commercial Knowledge to the Engineer.

ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street), at 8.—Prof. A. N. Whitehead: Uniformity and Contingency (Presidential Address).

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Engineers' Club, 39 Coventry Street, W.1), at 8.—Dr. E. F. Armstrong: Some Problems in Chemical Industry.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.30.—President' Opening Address.

ROYAL SOCIETY OF MEDICINE (Tropical Diseases and Parasitology Section), at 8.30.

TUESDAY, NOVEMBER 7.

ROYAL COLLEGE OF PHYSICIANS, at 5.—Dr. R. O. Moon: Philosophy and the Post-Hippocratic School of Medicine. (Fitz-Patrick Lecture).

ROYAL SOCIETY OF MEDICINE (Orthopædics Section), at 5.30.

MINERALOGICAL SOCIETY, at 5.30.—Anniversary Meeting.—W. A. Richardson: The Frequency-distribution of Igneous Rocks in Relation to Petrogenic Theories.—Miss Naggs: Crystallography of Organic Compounds.—Dr. G. T. Prior: The Meteoric Iron of Karee Kloof, Cape Province, and the Meteoric Stone of Leeuwfontein, Pretoria, S. Africa.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.

INSTITUTION OF CIVIL ENGINEERS, at 6.

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at London Day Training College), at 6.—E. J. G. Bradford: The Synthesis of Geographical Information.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Institution of Mechanical Engineers), at 8.—J. D. Morgan: High-Tension Ignition.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 8.—W. L. F. Wastell: Presidential Address.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Sir Arthur Keith: An Account of Mr. G. Despott's Excavation of the Cave of Ghar Dalam, Malta, and an Exhibit of Two Teeth of Neanderthal Man found there.

THE RÖNTGEN SOCIETY (at Institution of Electrical Engineers), at 8.15.—Sir Humphry D. Rolleston: Acute Constitutional Symptoms due to Radiations. (Presidential Address.)

ROYAL SOCIETY OF MEDICINE (Pathology Section) (in Laboratory of Imperial Cancer Research Fund), at 8.30.—Dr. A. N. Begg: Carcinomatous Infiltration of Nerves.—Dr. A. H. Drew: The Conditions for Growth *in vitro*.—Dr. W. Cramer: Blood Platelets.—Dr. B. R. G. Russell: Intra-cerebral Tumour Heteroplasty.—Dr. J. A. Murray: Multiple Primary Cancer.

WEDNESDAY, NOVEMBER 8.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—R. D. Oldham: The Earthquake of August 7, 1895, in Northern Italy.—R. D. Oldham: The Pamir Earthquake of February 18, 1911.—Dr. F. Dixey: The Geology of Sierra Leone.

ROYAL SOCIETY OF MEDICINE (Surgery: Sub-section of Proctology), at 5.30.—Sir Charles Symonds and others: Discussion on Gonorrhœal Stricture of the Rectum and its Treatment.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—R. L. Smith-Rose and R. H. Barfield: The Effect of Local Conditions on Radio Direction-finding Installations.

ROYAL SOCIETY OF ARTS, at 8.—Lord Askwith: The Value of Strikes and Lock-outs.

INSTITUTION OF AUTOMOBILE ENGINEERS, at 8.—Major F. Strickland and H. R. Ricardo: The Low Compression, Moderate Speed Engine *v.* The High Compression, High-speed Engine.

THURSDAY, NOVEMBER 9.

ROYAL SOCIETY, at 4.30.—*Probable Papers*.—Prof. H. E. Armstrong: Studies on Enzyme Action. XXIII. Homo- and Hetero-lytic Enzymes.—Prof. A. V. Hill and W. E. L. Brown: The Oxygen-dissociation Curve of Blood and its Thermodynamical Basis.—Dr. H. Hartridge and F. J. W. Roughton: The Velocity with which CO replaces Oxygen from its Combination with Hæmoglobin. Parts I. and II.—L. T. Hogben: Studies on Internal Secretion. I. The Effect of Pituitary (Anterior Lobe) Injection upon Normal and Thyroidectomised Axolotls.—L. T. Hogben and F. R. Winton: The Pigmentary Effector System. II.—A. Fleming and V. D. Allison: Further Observations on a Bacteriolytic Element found in Tissues and Secretions.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society) (Annual General Meeting), at 5.—Presidential Address.—H. W. Richmond: The Mathematical Problems of Shell-Flight.—W. R. Burwell: Asymptotic Expansions and generalised Hypergeometric Functions.—W. L. Ferrar: Determinants whose Elements are Determinants.—A. Kerekjártó: Transformation of Variables in a Multiple Integral.—C. Krishnamachari and M. Bheemasenaran: (1) The Properties of Certain Numbers. (2) Contribution to the Evaluation of Persymmetric Determinants.—L. J. Mordell: Trigonometric Series involving Algebraic Numbers.—H. W. Richmond: Analogues of Waring's Problem for Rational Numbers.

ROYAL COLLEGE OF PHYSICIANS, at 5.—Dr. R. O. Moon: Philosophy and the Post-Hippocratic School of Medicine. (Fitz-Patrick Lecture.)

THE WOMEN'S ENGINEERING SOCIETY (at 26 George Street, Hanover Square), at 6.15.—A. P. M. Fleming: Research.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—Dr. R. S. Clay: The History of the Photographic Lens.

ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.—Clinical Meeting.

INSTITUTE OF METALS (London Section) (at Royal School of Mines), at 8.—Prof. H. C. H. Carpenter: The Production of Large Crystals of Aluminium and some of their Properties.

FRIDAY, NOVEMBER 10.

ASSOCIATION OF ECONOMIC BIOLOGISTS (at Imperial College of Science and Technology), at 2.30.—Dr. E. S. Russell: The Work of the Fisheries Laboratory at Lowestoft.—Sir Sidney F. Harmer: The Present Position of the Whaling Industry.

ROYAL ASTRONOMICAL SOCIETY, at 5.

ROYAL SOCIETY OF MEDICINE (Clinical Section) at London Hospital), at 5.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—G. Temple: The Homographic Treatment of the Symmetrical Optical Instrument.—Prof. A. O. Rankine and C. J. Smith: The Structure of the Sulphur Dioxide Molecule.—A. S. Houghton: The Thermal Effect of Vapours on Rubber.—J. T. Robin: Demonstration of an Apparatus for Testing the Tensile Strength of Gas Mantles.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—A. Macaulay: The Development of Ball and Roller Bearings.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.

SATURDAY, NOVEMBER 11.

BRITISH PSYCHOLOGICAL SOCIETY (at King's College), at 3.—Miss L. G. Fildes: A Case of Word Deafness.—C. Fox: The Influence of Subjective Preference on Memory.

PUBLIC LECTURES.

SATURDAY, NOVEMBER 4.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—E. Lovett: The Folklore of the Cat.

MONDAY, NOVEMBER 6.

MIDDLESEX HOSPITAL MEDICAL SCHOOL (in Physiology Lecture Theatre), at 5.—Prof. Swale Vincent: Secretion and Internal Secretion. Succeeding Lectures on November 9, 13, 16, 20, 23, 27, and 30.

GRESHAM COLLEGE, at 6.—Sir Frederick Bridge: Music. Succeeding Lectures on November 7, 8, and 10.

CITY OF LONDON Y.M.C.A. (186 Aldersgate Street), at 6.—Sir Leonard Rogers: Insects and Disease: Some Triumphs of Medical Science.

WEDNESDAY, NOVEMBER 8.

CHARING CROSS HOSPITAL MEDICAL SCHOOL, at 3.—Sir Arthur Keith Evolutionary Tendencies in Man's Body (Huxley Lecture).

LONDON HOSPITAL MEDICAL SCHOOL, at 4.—Dr. P. Kidd: Forty Years in the History of Tuberculosis (Schorstein Memorial Lecture).

UNIVERSITY COLLEGE, at 5.30.—I. C. Gröndahl: Norway. Succeeding Lectures on November 15, 22, 29, and December 6.—At 6.15.—A. W. Flux: The Foreign Exchanges (Newmarch Lectures). Succeeding Lectures on November 15, 22, 29, December 6 and 13.

THURSDAY, NOVEMBER 9.

UNIVERSITY COLLEGE, at 5.15.—Prof. J. E. G. de Montmorency: Customary Law in London and other English City Areas. Succeeding Lectures on November 16, 23, 30, December 7 and 14.—At 5.30.—E. R. Vincent: The Palio of Siena, an Historic Italian Festival.

KING'S COLLEGE, at 5.30.—Miss Hilda D. Oakeley: The Stoic Philosophy. Succeeding Lectures on November 16, 23, 30, and December 7.

FRIDAY, NOVEMBER 10.

UNIVERSITY COLLEGE, at 5.15.—Dr. T. E. Gregory: International Exchanges.—C. Tate Regan: Problems of Evolution, with Special Reference to Fishes. Succeeding Lectures on November 17 and 24.

BEDFORD COLLEGE FOR WOMEN, at 5.30.—Dr. M. Cary: Ancient Geographical Exploration.

SATURDAY, NOVEMBER 11.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. W. A. Cunnington: The Natural History of Crabs.

SATURDAY, NOVEMBER 11, 1922.

CONTENTS.

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University Representation in Parliament.

THE last General Election was held in December 1918 under conditions entirely unfavourable for testing the revised system of university representation introduced by the Representation of the People Act of that year. Many thousands of the graduates of our universities were, figuratively or literally, removing from their minds and their habiliments the accumulated mud of four years' warfare. Women graduates, enfranchised for the first time both for university and for local constituencies, had been too much occupied with the problems, national as well as domestic, arising from the war, to explore the new opportunities of social and political service which the hardly-won privilege of the vote had gained for them. We need not attempt to examine in detail the political conditions which faced the nation at the conclusion of the war. Personalities and powers chose to act in accord with the transient temperament of a dazed and somewhat irresponsible people, a temperament which we now recognise, after four sobering years, was based on unsound economics and impracticable idealism.

If the lessons of the post-war period have been taken to heart, it is our duty in the present General Election to ensure so far as possible the return of members qualified by natural gifts, by training, by experience, to give to parliament expert and disinterested counsel and to press for measures of reconstruction exhibiting sound and lasting principles. It is from this point of view that we propose to discuss the question of university representation. An old and peculiar element in our electoral system, the principle of university representation was, before the war, the subject of acute political controversy. Threatened with extinction, it has survived powerful and persistent attacks and, for reasons to some extent extraneous to the abstract merits of the case, has emerged from the war with enhanced prestige and extended application.

What then is the history and significance of university representation in parliament? Its originator, James I., was friendly-disposed towards the ancient universities of Oxford and Cambridge and indeed to universities in general, for he confessed that if he were not a king he would wish to be a university man. By latters patent under the Great Seal of England he commanded that two grave and learned men professing the civil law should be chosen by each university to serve as members of the House of Commons. In those days parliamentary representatives were usually chosen in pairs, possibly for mutual succour, and the representation of the ancient universities by two members each has remained undisturbed since the beginning of the seventeenth century. Originally the

enfranchisement of the universities was regarded as "a great favour to the universities as to the prosecuting their affairs in Parliament." This supposed benefit was soon recognised as to some extent illusory, for whereas under the old dispensation members who had been students of the universities "would stand up as occasion offered on behalf of their respective mothers," this duty was relegated to and, it is said, imperfectly discharged by the elected representatives of the universities. Candidly, we should find it difficult to justify the special representation of universities in the House of Commons if its sole object were deemed to be purely institutional, however important as national institutions our universities may be.

In pre-war days Mr. Asquith's complaint against university representation was that any constituency, whether you call it a university or anything else, will in the long run send to the House of Commons a man whose political opinions are in accord with the predominant opinions of those who sent him; and in support of this contention he was able to quote personal examples, particularly the treatment of Sir John Gorst by the University of Cambridge. This argument is not without weight, but it fails to demonstrate that a group of men and women of similar education and a common loyalty does not form as good a constituency for the election of a member of parliament as a group of men and women who happen to live in a selected locality such as South Kensington or East Ham. As Maitland points out, the ancient idea was the representation of communities, of organised bodies of men which, whether boroughs or counties, constantly met as wholes, and enjoyed common rights and duties. That system has given way as regards local constituencies to the representation of numbers, of unwieldy masses of men and women organised only for the purpose of choosing members. But this opens up a wide constitutional question which cannot be treated, adequately and appropriately, in these columns.

We prefer to base the case for university representation on Lord Balfour's argument—that it is a method of getting into the House of Commons, men of science, men of scholarship, men of special and peculiar gifts quite alien from the ordinary working politician. The fact that university representation provides almost the last survival of plural voting enforces this argument. Representation of special interests in parliament may not be, in the abstract, desirable. Like the weather, it has to be accepted as a mysterious fact; and so long as labour, in a narrow sense, co-operation, "the trade," temperance, and many other interests are able to secure their representatives through the ordinary channels, we shall be well advised to implement the traditional method of securing the representation of science and education and the election to parliament of men and women whose lives have been consecrated, not to the study of the eclectic arts of the politician, but to the pursuit of truth and the advancement of learning. If this thesis be accepted, voters should strive to express in university elections the purpose and ideal which are inherent in this method of election.

Encephalitis Lethargica.

Ministry of Health. Reports on Public Health and Medical Subjects, No. 11: Report on Encephalitis Lethargica. By Allan C. Parsons; with contributions by Dr. A. Salusbury MacNalty and J. R. Perdrau. Pp. x+344. (London: H.M. Stationery Office, 1922.) 10*s*. net.

THE report on the subject of encephalitis lethargica, recently issued by the Ministry of Health, has a wider than medical interest, as illustrating the still considerable range of disease, of which our knowledge is so partial that preventive action is almost entirely impracticable.

This "new disease" appears to have been first recognised as distinct from other recognised diseases by Von Economico in Vienna in the year 1917. In the early part of 1918 cases were simultaneously reported in Sheffield and London, and prompt action for their investigation was undertaken by the Local Government Board, altogether some 230 cases being recognised during the first six months of that year. The symptoms of this disease, comprising somnolence, from which the patient is roused with difficulty, paralysis of ocular and other muscles, as their most marked features, bore some resemblance to those associated with botulism, and the first task of the earlier investigation was to eliminate the food poisoning to which botulism is due as a cause of the symptoms. This point the earlier official investigations definitely settled. A more difficult question was to decide whether—as was influentially urged—the disease was not a variant of poliomyelitis, which had been recently epidemic, especially among children.

The hypothesis that the two diseases both belonged to what is known as the Heine-Medin group, differing merely in the locality of the nervous lesions, was attractive; but for reasons detailed in the earlier governmental report and confirmed in the present report, this hypothesis, in the opinion of most observers, was satisfactorily eliminated. Similar considerations exclude influenza as a hydra-headed monster, with poliomyelitis and encephalitis lethargica as variants caused by the same virus. In Dr. Parsons' part of the present report the distinctions between these three diseases are judicially stated. Poliomyelitis prevails chiefly in late summer and autumn, encepha-

litis lethargica in the winter months of December to February inclusive. Poliomyelitis, unlike encephalitis lethargica, attacks chiefly children. Experimentally, the unidentified virus of each disease appears to be a filtrable organism, that of poliomyelitis being readily transmissible to monkeys; that of encephalitis lethargica being transmissible with difficulty and only from acute cases of the disease.

The detailed pathological and bacteriological evidence of the separate identity of these two diseases cannot be given here, but it is set out lucidly in Dr. MacNalty's contribution to the report under review.

The separate identity of influenza is sufficiently indicated by its proverbial infectiousness, whereas multiple cases of either encephalitis lethargica or poliomyelitis are a rarity. Even if it be assumed that the apparent partial non-infectiousness of these two diseases is due to the incarceration of the hypothetical influenzal virus in the deep parts of the central nervous system, it would still need explanation that the virus when introduced in these cases did not cause, *e.g.* in other members of the same family, ordinary attacks of influenza. There is no systematic parallelism in the prevalence of the three diseases; and as Dr. Parsons remarks, "the epidemic behaviour of influenza and encephalitis lethargica do not seem to represent a mutuality of any constant nature." The rarity of respiratory complications in cases of encephalitis lethargica is in itself a strong argument against community of origin.

The present reports by Dr. A. C. Parsons, Dr. A. S. MacNalty, and Dr. J. R. Perdrau, with a prefatory statement by Sir George Newman, bring our knowledge of this disease up-to-date. The value of the report is enhanced by an elaborate bibliography of 1243 items, which will be most useful to students of this obscure subject. The extent of incidence of the disease may be gathered from the statement that in 1919, 541 cases, and in 1920, 890 cases, were recognised and notified, and it is not without significance that cases of poliomyelitis became much fewer in the same period. This may be explained on the supposition that a common virus at different times strikes at different parts of the nervous system; but the totality of evidence, epidemiological, clinical, and pathological, points in another direction.

We began this necessarily sketchy review with a statement that the group of diseases mentioned above do not yet come within the range of practical preventive medicine. When the agitation in one of our chief daily journals in favour of the much-needed Ministry of Health was at its height, the failure of the Local Government Board to control the pandemic of influenza was a big item in the indictment against it. This report, like the recent official report on influenza, should give pause to those who anticipate that uncontrollable diseases will be made controllable by changing the name of a government department. It has to be confessed—and from a scientific point of view it is most important to face the fact—that "respiratory infections" like influenza and (presumably) poliomyelitis and encephalitis lethargica are almost entirely uncontrollable, and will remain so until some new method of securing immunity is discovered, or until a standard of hygienic precautions is reached in respect of coughing, and even of speaking, which is not likely to be attained universally in this century. Even were it attainable, would life then be tolerable?

Meanwhile, every channel of investigation needs to be pursued; and a word of praise may be given in this connexion to the wisdom of making encephalitis lethargica notifiable in 1918 as soon as its separate existence was fairly well established. By this means it has become practicable to investigate each notified case and to demonstrate the general absence of personal infection from recognised cases. By implication we are led to infer that slight unrecognisable cases of the disease exist which cause its spread; but this fact further emphasises the uncontrollable character of the disease in present circumstances.

Encephalitis lethargica has been described above as a "new disease." This merely means that it is a newly recognised disease. Crookshank and others have searched older literature and found descriptions which tally with this disease, occurring commonly in association with epidemics of influenza; and there can be little doubt that the apparent strict modernity of encephalitis lethargica is indeed apparent and not real.

The Telescope.

The Telescope. By Dr. Louis Bell. Pp. ix+287. (London: McGraw-Hill Publishing Co., Ltd., 1922.) 15*s*. net.

INVENTION is not the prerogative of the learned. The telescope, we are told, was the creation of the two little children of an observant father, a spectacle-maker of Holland. But, however casual the origin, its development was the result of laborious and progressive experiment and study, an excellent account of which is given by Dr. Louis Bell in the introductory chapter of the work before us.

There are partisans who will dissent from some of the author's historical statements, and many who will object to the presentation of Newton as a "blunderer," a "bungler," and a man who promptly jumped to a conclusion. As a boy, Newton tested the wind by jumping with and against it, and Sir David Brewster remarks: "This mode of jumping to a conclusion, or reaching it *per saltum*, was not the one which our

philosopher afterwards used." Dr. Bell has the same authority for the statement that, when investigating the relationship of dispersion to mean refraction, Newton mixed sugar of lead with the water. Traced to its source, however, this so-called fact appears to be merely a suggestion of Mr. Michell, a friend of Dr. Priestley, offered as an explanation of an otherwise inexplicable experimental result and based on Newton's use of *saccharum saturni* in other experiments.

Flint glass good enough for quantitative observation could scarcely have existed in 1666, for about a hundred and forty years elapsed before Guinand resolved the optical glass problem. It was more the absence of suitable material that "delayed the production of the achromatic telescope by some three-quarters of a century" than any action of Newton. Indeed, Sir Isaac Newton should be honoured for his prescience in recognising that in the circumstances the practice of astronomy could best be advanced by the development of the reflector.

"The Telescope" has been "written for the many observers who use telescopes for study or pleasure and desire more information about their construction and properties," the information hitherto published on the subject being "for the most part scattered through papers in three or four languages and quite inaccessible to the ordinary reader." Within the limits of a single volume the author has collected a great deal of essential information that the general reader will find both useful and interesting.

Following the historical introduction there are chapters on the modern telescope, optical glass and its working, properties of objectives and mirrors, mountings, eyepieces, hand telescopes and binoculars, accessories, the testing and care of telescopes, setting up and housing, seeing and magnification, and finally, a brief appendix on work for the telescope.

The book is not free from mistakes. In the description, for example, of the Galilean glass, the field is stated to be approximately measured by the angle subtended at the centre of the objective by the pupil. The description given in "The Telescope" by Herschel, although theoretically incomplete, might have been copied with advantage, as it explains how the field is determined by the diameter of the objective and the possible displacement of the eye. In chapter 7 the so-called Dove prism system is described as the rudiment of the prism binocular or shortened telescope. Such a system, unlike the earlier Porro combination, cannot be placed in the convergent beam and it cannot serve to shorten the telescope.

Those to whom style and composition are of importance will regret the inelegance of such expressions as "credulous twaddle," "pricked up its ears," and "blast of hot air." Their use detracts from the pleasure of perusal of a welcome addition to the literature of the telescope. JAMES WEIR FRENCH.

An Elementary Work on Coal-Mining.

An Elementary Text-Book of Coal-Mining. By Robert Peel. Revised and enlarged by Prof. Daniel Burns. Twentieth edition. Pp. viii+420. (London and Glasgow: Blackie and Son, Ltd., 1922.) 6s. net.

THIS little book is, as its title expresses, a book dealing with the most elementary principles of coal-mining. It has obviously answered its purpose extremely well, and has suited the needs of those to whom it is particularly addressed, as is only too evident from the fact that it has reached its twentieth edition since its original publication twenty-nine years ago. It need scarcely be said, therefore, that the general arrangement and style of the work are beyond criticism, otherwise it would not have survived the rigorous test of experience through which it has passed. Any review of the work must therefore be based upon the nature of the revision to which it has been subjected.

It may fairly be said that the labour of revising such a work falls under three main heads, namely, first to eliminate all possible blunders; secondly, to bring the work thoroughly up-to-date, and thirdly, to see that there is no ambiguity likely to puzzle the student. Unfortunately, it cannot be said that the revision stands the test under any of these three heads, and a couple of illustrative examples of shortcomings may be quoted under each. There are, for example, blunders in spelling, such as "Plainmeller" for "Plenmeller" and "Maudline" for "Maudlin." Under the second heading we have such statements as that the deepest borehole in the world is that at Schladebach, which attained the depth of 956 fathoms. This was true once, but the deepest borehole in the world to-day is that at Czuchow, Rybnik, Upper Silesia, which has attained a depth of 7350 feet. Again, the statement that of centrifugal fans those most generally adopted are the Guibal, Waddle, and Schiele was true once, but is not true to-day. The only reference given to the Kind-Chaudron method of sinking in this country is its first application at Marsden, the far more important, instructive, and recent sinking at Dover not being mentioned. Under the third head we get such a statement as that when it is inconvenient to state work in foot-pounds as the unit of work a higher unit is adopted termed horse-power. The confusion between work and power, to which most students are prone, is one that should never be allowed to creep into a text-book, where the difference between the two standards should be very clearly explained. Again, in dealing with the thickness of tubbing, two

formulas are given, one due to Greenwell and the other to Aldis; an example is given of the use of the former, which is here worked out, giving a thickness of 1·19 inches; if the reviser had worked out the same example by the second formula here given, he would have obtained a thickness of 1·98 inches, yet no hint is given to tell the student that the two formulas do not agree, or to help him in any way to reconcile so grave a discrepancy.

It is also a pity that so many of the illustrations are mere sketches, and badly executed at that. As an example Fig. 104, which is intended to be the plan of a horizontal winding engine, may be quoted; an intelligent boy of twelve who had seen a winding engine would probably in his drawing indicate that there are such things as valves and valve-rods.

It has been thought advisable to direct attention to the points in which this little book falls short of the standard to which it might so easily be raised, because, as already stated, it has evidently a very decided sphere of usefulness, and in a work of this kind addressed to the beginner it is pre-eminently necessary that he shall receive no wrong impressions and shall be left with nothing to unlearn when he advances to the higher stages of the subject.

Essays on French Science.

Discours et mélanges. Par Émile Picard. Pp. v+292. (Paris: Gauthier-Villars, 1922.) 10 francs.

THIS volume contains discourses, short essays, and obituary notices of some distinguished French men of science. It may be warmly recommended, more especially on account of the obituary notices, which do not confine themselves—as is too frequently the case—with an account of the work done, but tell us something of early surroundings, education, and temperament, and thus bring out the personality as well as the results achieved. It is not only that the account gains in interest thereby, but the information allows us to judge more adequately of the individual influence exerted on contemporary science.

Pierre Duhem's work is recognised in this country by every one familiar with thermodynamics, but the personal touches which M. Picard's account supplies give us just what is wanted to appreciate the full value of the man. Poincaré is better known to us, perhaps Darboux also, but we shall find here something new about them as well as about others with whose work M. Picard deals. The notice of Lord Kelvin is excellent.

The author does not always confine himself to those branches of science which he has himself enriched by valuable contributions. As secretary of the Academy of Sciences he has to undertake the duty of explaining the ground for the award of prizes, some of which, like that founded by Mr. Osiris, include a wide range of subjects. We thus find short discourses on "French Aviation in 1909," and even on "Antityphoid Vaccination." A lecture on the diminution in the birth-rate was no doubt inspired by the atmosphere of the war, and some of the other writings are even a more direct outcome of the anxieties of the time at which they were written. Here it is perhaps allowable to make one criticism. In the essay on "Les Sciences mathématiques en France," M. Picard shows so much knowledge of scientific history in other countries and such fair appreciation of the international aspect of science, that one regrets the inclusion of an article that originally appeared in the *Revue des Deux Mondes*: "L'histoire des sciences et les prétentions de la science allemande." There is no doubt much in it that is true, but it is not written in the dispassionate and eminently fair spirit which pervades the rest of the book and it strikes a discordant note.

Graphical Methods in Crystallography.

Graphical and Tabular Methods in Crystallography as the Foundation of a New System of Practice: With a Multiple Tangent Table and a 5-Figure Table of Natural Cotangents. By T. V. Barker. Pp. xvi+152. (London: T. Murby and Co., 1922.) 14*s.* net.

IT has been anticipated for some time that Mr. Barker would publish an account of the graphical and tabular methods in crystallography which he has been teaching at Oxford, and that his book would include a description of the form of two-circle goniometry and its special application to crystallochemical analysis, which he recommends as the result of his studies in Russia under the late Prof. Fedorov. The present volume only very partially fulfils these expectations, crystallochemical analysis being reserved for a further publication. So far as it goes, however, the book is a valuable presentation of extant graphical methods, and it concludes with a most useful table of multiple tangents.

The main purposes of the monograph are "to provide the researcher with a select collection of exact graphical methods, which personal experience has proved to be both accurate and time-saving; to discuss the relation of these methods to formal processes of computation; and, finally, to outline a new system of practice." The methods described involve the use of both the stereographic and gnomonic projections, and are a mixture of the well-known ones due to Penfield, Hutchinson, V. Goldschmidt, and Fedorov. A crystallographic protractor is described and recommended, which in itself is a happy combination of the features of the Penfield, Fedorov, and Hutchinson protractors.

The new system of practice, which forms the subject of the last chapter, is obviously chiefly concerned with rapid (time-saving) work, with a view to the inclusion of some crystallographical account of all new substances, as well as existing ones, in a comprehensive catalogue, or to the identification of a crystallised substance by the comparison of such rapidly acquired data with that contained in such a compendium of measured substances. Two-circle methods are used, and the table of angles characteristic of a substance consists of the theodolitic ϕ azimuth and ρ altitude values. It is suggested that "two, or at most three, crystals be measured," that "the indices be determined by a time-saving method," that "the mean observed angles be published without any citation of limits," and that "the practice of computing theoretical angular values (apart from those involved in the elements) be discontinued." This may satisfy Mr. Barker, and may possibly be adequate for the particular purpose which he has in view. But it is most sincerely to be hoped that serious crystallographic research is not to be so circumscribed, and that absolute accuracy will be placed before time-saving. Otherwise we shall rapidly revert to former chaos. It has been, indeed, only by the most accurate and laborious work, in which time was regarded as subservient to the highest accuracy, that the subject has been brought to its present high position; this alone has rendered possible the wonderful confirmation, by the absolute measurements now made by the Bragg X-ray spectrometric method, of the work of the later crystallographers.

Our Bookshelf.

Magnetism and Electricity. By J. Paley Yorke. New edition, completely rewritten. Pp. viii+248. (London: E. Arnold and Co., 1922.) 5*s.* net.

WRITTEN in colloquial language, this book, which is a first-year course on magnetism and electricity, will appeal to many beginners besides the students in technical institutions, for whom it is primarily intended. "These students have one great quality: they are out to learn and to understand, and as they are not hampered by the immediate necessity of cramming for any particular examination, are able to enjoy the pleasures of understanding instead of suffering the terrors of memorising. . . . Memory is useful for examinees, but understanding is essential for engineers." There is abundant evidence throughout these pages that the author is familiar with the difficulties met with by the beginner, and he is always careful to explain the technical terms which are apt to be used freely by text-book writers who have almost forgotten that their jargon is not that of the man in the street. Magnetism is first dealt with, and then the ideas of static and current electricity are introduced. The author is particularly successful in developing the self-contained water circuit analogy, the basic idea of which is that energy can be distributed without any consumption of the water. Experience has convinced him that the plan of introducing the measurement of electrical energy at an early stage is very effective. The basic ideas of electro-magnetic induction are discussed in some detail, and in the final chapters the phenomena of electrostatics are briefly treated. We can recommend the book to those for whom it is intended, but fear to think what the modern relativist would have to say to such statements as, "Anything which has weight is called *Matter*: magnetism is therefore not matter" (page 21); "This something which is called energy has not got weight" (page 57)!

The Climates of the Continents. By W. G. Kendrew. Pp. xvi+387. (Oxford: Clarendon Press, 1922.) 21*s.* net.

MR. KENDREW strikes new ground by giving a description of the actual climates of the regions of the world. The scope of the treatment must naturally vary with the nature of the original sources which are available, but no detailed local descriptions are attempted. A general knowledge of meteorology is assumed. There is no explanation of the omission of polar climates, north and south. Quite enough is now known of these climates to enable useful accounts to be included in a book of this sort. The oversight mars the usefulness of the volume. We notice that Mr. Kendrew adheres to the idea that the heating of north-west India furnishes an explanation of the south-west monsoon. The comparatively poor rainfall in the north-west he attributes to the previous course of the winds reaching that region, which has deprived them of much of their moisture. According to Dr. G. C. Simpson, the explanation is far more complex, and depends on several factors, of which one of importance is the dry upper-air current from the west, which prevents cloud formation in the ascending air. These and other recent theories regarding the monsoon are not discussed by Mr. Kendrew. There are many clear diagrams and maps, and numerous meteorological data. All students of geography will be grateful for this well-arranged and lucidly written volume.

Miracles and the New Psychology: A Study in the Healing Miracles of the New Testament. By E. R. Micklem. Pp. 143. (London: Oxford University Press, 1922.) 7*s.* 6*d.* net.

THIS work is concerned with a comparison between the healing miracles described in the New Testament and the case records of modern psychotherapy chiefly drawn from war practice. A brief description of modern psychotherapeutic measures is given, but the complexity and difficulty of the subject almost necessarily makes such a sketch confusing to the uninitiated reader. The sources of the New Testament narratives are examined and the inexactitude of observation is commented upon, especially in the fourth gospel. The current superstitions anent the relationship of sin and disease and demonology are noticed as likely to colour and detract still further from the trustworthiness of the descriptions.

The miracles are then dealt with *seriatim*, and where possible, recent parallel cases are quoted. Finally, the author disclaims the belief that all the subjects of the

healing miracles were suffering from what would now be called functional disease, but seeks to support his thesis that these works of Christ were in accordance with natural laws, by quoting cases (not always convincing) of the effect of psychotherapy on organic disease.

The general impression of the book is that while the author has made out a plausible and even probable argument that the miracles were not supernatural phenomena, his parallels are not sufficiently exact to carry absolute conviction. Such exactitude could never be obtained in view of the unscientific observations of the New Testament cases by men who certainly thought these works were supernatural and were quite untrained in medical knowledge. As the author points out, even Luke "the physician" uses terms rather less exact from the medical point of view than do the others. The book is certainly readable and interesting, but belief that the ministrations referred to in it were miraculous is not likely to be disturbed by the author's scientific consideration of the evidence upon which it is based.

A Book about Sweden. Pp. 183. (Stockholm: A.-B. Nordiska Bokhandeln, 1922.) n.p.

WE have received through the Swedish Consulate-general in London a copy of "A Book about Sweden," published in Stockholm by the Swedish Traffic Association. It is a compact guide, very fully illustrated, written in English for those who may wish to visit Sweden, or for those who have not yet realised what a charming and novel field awaits the tourist, accustomed to think of Europe as centred in Grindelwald or Assisi. The photograph of the s.s. *Saga*, now running between London and Gothenburg (Göteborg), invites the Englishman by a reminder of his Viking blood. The description of the country and its human occupations is geographical, and many of the views, such as those in Lappland, are difficult to obtain from other sources. That of the iron-mountain of Kiruna, lit up electrically for work in the long winter night, illustrates one of the great romances of Swedish industry. The account of power-developments in general will interest scientific readers. We are shown the fascination of Abisko, remote within the Arctic Circle; but nothing is said about the summer mosquitoes, and the happy tourists at Torneträsk seem to be going about unveiled. The manifold charm of Stockholm, a city unlike any city, the sweet clean beauty of the forest country, the rush of waters at Porjus and Trollhättan, are here simply set before us. If one knows Sweden already, it is all the more delightful to turn these pages, and, as the Dalarna poem says, to long for her again. This little handbook may be recommended to British teachers of geography. G. A. J. C.

14,000 Miles through the Air. By Sir Ross Smith. Pp. xii+136. (London: Macmillan and Co., Ltd., 1922.) 10s. 6d. net.

THIS small volume by the late Sir Ross Smith marks an epoch in the history of flying, for it is a record of the first flight from London to Australia. Sir Ross Smith and his brother, Sir Keith Smith, accompanied by two air-mechanics, Sergeants J. M. Bennett and W. H. Shiers, entered a Vickers-Vimy aeroplane for the prize of 10,000*l.* offered by the Commonwealth Government in 1919 for a flight from England to Australia in 30 days. As is well known, the two brothers won the race. They left Hounslow on November 12, 1919, and reached Darwin on December 10, 1919. From there the flight was continued to Sydney, Melbourne, and Adelaide. The actual time spent in flying between London and Adelaide was 188 hours 20 minutes. The longest spells in the air were 730 miles from Bundar Abbas to Karachi, and 720 miles from Karachi to Delhi. The brevity of the book makes it all the more vivid, and helps the reader to realise the speed of travelling by air. The author gives few incidents and certainly dwells lightly on the difficulties encountered. But there are some exciting passages, of which one of the best is the flight through the clouds between Rangoon and Bangkok, and the groping descent with the fear of collision with the heights of the Tenasserim Ranges. The book is well illustrated, the pictures of cities taken from the air being very striking. It is much to be regretted that this high-spirited airman lost his life at the very start of his next great adventure, a few years later, of the flight round the world.

Evolutionary Naturalism. By Prof. R. W. Sellars. Pp. xiv+349. (Chicago and London: The Open Court Publishing Co., 1922.) n.p.

THE author of this book is one of the "critical" realists. The difference between a neo-realist and a critical realist would seem to be that the former regards the datum of perception as identical with the object of knowledge, while the latter distinguishes between them. The neo-realist says that we know the physical existence in perceiving it, the critical realist says we know the existence of the physical thing but what we perceive is its essence. Objects exist, but only their content and not their existence is perceived. The special theory which Prof. Sellars names evolutionary naturalism is based on this distinction. Its two great enemies, we are told, are Platonism and Kantianism, both of which are supernaturalistic. The theory is worked out in laborious detail and applied to the different problems of philosophy.

Greek Biology and Greek Medicine. By Dr. Charles Singer. (Chapters in the History of Science, I.) Pp. 128. (Oxford: Clarendon Press, 1922.) 2s. 6d. net.

DR. SINGER here gives a succinct account of the general evolution of Greek biological and medical knowledge. The biological portion of the book is arranged in three sections, "Before Aristotle" (18 pp.), "Aristotle" (36 pp.), and "After Aristotle" (24 pp.); the remaining 50 pp. being allotted to Greek medicine. The section on Aristotle appears here for the first time; the others are reprinted, with slight amendments, from "The Legacy of Greece." All who are interested in the biological sciences will be glad to have in this cheap and convenient little volume an authoritative account of the works of Aristotle, Galen, Hippocrates, and others who laid the foundations of the science of life; and the majority of readers will be amazed at the extent of our indebtedness to Greece.

Letters to the Editor.

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The Structure of the Red Lithium Line.

IN a recent number of the Proceedings of the Royal Society Prof. McLennan and Mr. Ainslie have announced the interesting discovery of a new component of the line $\lambda = 6708$ in the spectrum of lithium, the line appearing, under the conditions of excitation employed by them, as a quartet. They proceed to discuss the possibility of this structure being due to two pairs of lines, each pair being assigned to one of the isotopes of lithium. To the present writer it appears that the new components cannot be accounted for in this manner.

The structure of the line in question has been investigated by Kent (*Astrophys. Journ.* vol. 40, p. 337, 1914), Takamine and Yamada (Proc. Tokio Math. Phys. Soc., vol. 7, No. 18, p. 339, 1914), Zeeman (Proc. Roy. Acad. Amsterdam, p. 1130, Feb. 1913; p. 155, Sept. 1913), King (*Astrophys. Journ.*, vol. 44, p. 169, 1916), and the writer (Proc. Roy. Soc. A, vol. 99, p. 101, 1921). Kent, and Takamine and Yamada, observed it as a single pair of emission lines, and Zeeman, who investigated the absorption spectrum, also recorded a single pair of lines, with the reservation that with a high density of the absorbing vapour other lines made their appearance. Zeeman considered that these lines which appeared at high vapour densities were analogous to lines observed in the sodium spectrum by R. W. Wood. King, who investigated the structure of the line in the arc and in the tube-furnace, found that with a low vapour density the line appeared as a simple pair, and that at higher vapour densities a third component appeared; with a still greater amount of vapour the phenomena were complicated by reversal. King has published one photograph in which, owing to reversal, the line has the appearance of a quartet. McLennan and Ainslie used a vacuum arc under conditions in which it would appear that the density of the lithium vapour must have been very great, and one may surmise that this condition is essential for the appearance of the fourth component.

It seems, however, that under appropriate conditions the line appears as a simple pair, and our ideas as to the nature of isotopes would have to be profoundly modified if the pairs due to the two isotopes were found to require different conditions for their excitation. If the four components were really two pairs due to the two isotopes they should always appear together with an invariable intensity ratio of 1 : 16. The line can be seen easily as a simple pair in a carbon arc in air if the poles are brushed over with an exceedingly dilute solution of a lithium salt. The components are then less sharp than when the vacuum arc is used, and the main difficulty is to have little enough lithium in the arc, so as to avoid the appearance of the third component and complex structures due to reversal. In the vacuum arc the third component appears very readily unless the amount of lithium vapour is small. It may further be mentioned that the relative intensities of the components are not in good accordance with the view that they are due to the two isotopes.

From a theoretical point of view also, there are grave difficulties. The calculated separation, on Bohr's theory, of corresponding lines in the pair, is about 0.087Å., the observed separation being between three and four times as great. McLennan and Ainslie put forward the suggestion that the separation may in fact be the product of the "calculated separation" and the atomic number; but the correctness of the calculated separation has been verified by the observed differences between the lines of the Balmer series of hydrogen and alternate members of the ζ Puppis series of helium, and in this case the agreement is exact and the "calculated separation" does not require to be multiplied by a factor of 2, the atomic number of helium. T. R. MERTON.

The Clarendon Laboratory, Oxford,
October 19.

The Mechanism of the Cochlea.

IN view of the discussion in these columns towards the end of 1918, and the letters which followed it at various times, the model designed by Mr. George Wilkinson, of Sheffield, and described in NATURE of October 21, p. 559, is of much interest and importance. It is obvious that the construction of such a model presented many mechanical difficulties, and great credit is due to Mr. C. E. Stewart, the mechanician of Prof. Leathes's laboratory, for the successful result. It may, therefore, be useful to mention that a full description was published in the *Journal of Laryngology and Otology*, of September last, a short account having been given in the Proceedings of the Physiological Society (*Journal of Physiology*, vol. 56, p. ii). The apparatus was demonstrated to the Physiological Society in December 1921, as also to the British Association in September 1922.

I take it that others besides medical students have been dissatisfied with most of the theories put forward to avoid the difficulties thought to be involved in the Helmholtz view of the resonance of the basilar membrane. Those theories in which this membrane is supposed to act as a whole, like a telephone diaphragm, or by "pressure patterns," are inconsistent with the progressive differentiation of structure along the membrane, in addition to being in conflict with what is known of the conducting properties of nerve fibres. Thus the views suggested by Ewald, Rutherford, Waller, and Wrightson are unacceptable. It appears that although Helmholtz had referred incidentally to "loading" of the vibrating elements of the membrane by the liquid in which it lies, the great importance of this factor was first realised by Mr. Wilkinson and investigated experimentally by him. His model is doubtless capable of still further improvement, but even in its present form many problems would have light thrown upon them by its behaviour. The degree of damping and the spread of resonance to neighbouring elements may be mentioned. The number of waves required to excite sympathetic resonance of a tuned element may perhaps be determined. Some degree of spread is not inconsistent with the Helmholtz theory, since the amplitude of vibration of other elements than those in tune with the vibrations received might well be too small to stimulate the nerve endings. Dr. Gray has shown that a similar cutting out of small stimuli takes place in the localisation of a point of pressure in the skin.

It is of interest to note that the model responds to a tuning-fork held in contact with the brass case, just as the cochlea does to conduction through bone. This indicates that the impulses given by the movements of the stapes are the same as those of sound waves directly transmitted through water, as would be expected from theoretical considerations.

Mr. Wilkinson also points out in his paper the necessity for the basilar membrane being continuous. If the fibres had gaps between them, no regular loading of the vibrating elements would be possible.

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THE description of Dr. Wilkinson's model of the cochlea in NATURE (October 21, p. 559) recalls Dr. Yoshii's experiments on guinea-pigs. Yoshii operated with long-sustained notes from whistles of different pitches, and concluded from the resulting lesions in the organ of Corti that the pitch of the note determines the region of maximal displacement of the basilar membrane. But as he used the same pressure to blow the different whistles (*Zeitschr. f. Ohrenheilkunde*, 58, 1909, p. 205), the product a^2n^2 had a constant value, *i.e.* the greater the frequency of the note employed, the less the amplitude of its vibrations, which shows at once that Yoshii's results do not support his conclusions. If Dr. Wilkinson's model of the cochlea is a good one, it will show that the locus of maximal vibration in the basilar membrane for a given note shifts toward the distal end when the intensity of that note is increased, and toward the fenestral end when its intensity is diminished; and will thus demonstrate once again that the principle of resonance can find no application in the internal ear.

W. PERRETT.

University of London, University College, Gower Street, W.C.1, October 26.

An Empire Patent.

IN the article appearing in NATURE for September 30, p. 437, with the above heading, there is the underlying assumption that the status of the inventor should be assimilated to that of the author, namely, that both should be secured a world-wide monopoly at a minimum expenditure. Will you allow me to present in your columns a more philosophical view of the history and function of patent law in relation to the growth and decay of civilisation, from which it will be seen that the favourable treatment of the inventor cannot be based upon international principles. It is part and parcel of a purely national and competitive policy.

The processes by which the characteristics of a higher civilisation are transmitted to races of lower culture appear to be based ultimately upon biological laws. Pressure generated within the walls of the higher civilisation drives out its more enterprising citizens to seek their fortunes elsewhere, and the new colonists, by interbreeding with the native stock, impart to it their own superior characteristics. The outward forces tending to the disruption of the older organisation may be economic, religious, or political, or some combination of these. The process may occupy centuries or be accomplished within as many decades. Thus the industrialisation of the English occupied many centuries—the periods of advance in the reigns of Edward III., Elizabeth, and Charles II. being associated with large influxes of the industrial population of the Continent. On the other hand, the rapid rise of the United States to the rank of a first-class power has been the work of the past fifty years. In both these instances national development was preceded by conditions which favoured the introduction and assimilation of a higher strain from abroad. Maintaining a civilisation at a high level in turn rests upon its compliance with the same biological law.

Talent and enterprise are the natural monopoly of a relatively small fraction of the human race. These characteristics are transmitted by direct descent, reproducing themselves in successive generations. How closely the fortunes of an industry may be associated with particular family names—notwithstanding the dilution which each family undergoes by marriage—is not sufficiently recognised. It has, for example, been shown recently that iron founding was introduced into this country by a body of French workers in the reign of Henry VII. A leading family which came in at this period were the Leonards, members of which migrated to the United States in the seventeenth century; whence the saying arose, that "where you find ironworks there you find a Leonard." But there is some reason to suppose that the French iron-founders originally came from Italy. Hence the Leonardos, Lennards, or Leonards may trace their connexion with this industry perhaps for 500 years. This reappearance of the same characteristics in successive generations of a family, and the predominance of the imported families in the higher ranks of culture—other than that of administration—can be verified by reference to the National Directories. A Stirling is generally an engineer, a Hochstetter a mineralogist, a Matthiessen a physicist. These families form a cosmopolitan body whose services can be enlisted by any country which possesses the power and foresight to attract them. Thus the maintenance of a civilisation depends upon its power to retain the services of its best native stock, while constantly reinforcing it from outside sources.

At an early period in the history of this country, bringing in companies of skilled artisans from abroad became an accepted feature in the exercise of the Royal prerogative. In the reign of Elizabeth a new feature was introduced, whereby, in addition to the Royal protection and favour, an exclusive right of manufacture was granted to any institutor of a manufacture not in use within the realm at the date of the Letters Patent. This system, though opposed to the tenets of the Common Law, received a grudging recognition in the Statute of Monopolies in 1624. Under this Statute the rights of the native inventor rested on the fact of his profession that he was willing and able to institute a new industry. The efficacy of the law rested upon two principles: that it attracted foreign strains of inventive ability, while stimulating that of the native inventor. Anthropologists are agreed that there is a fairly equal distribution of ability in different races. The English Crown recognised the deficiency in native stock and made good its defects by selective racial interbreeding.

The first blow to the efficiency of the English patent system was struck in the last quarter of the eighteenth century by a judge of the King's Bench. It is well known that there is a remarkable hiatus in the continuity of patent law decisions for the century and a half subsequent to the Statute of Monopolies. The reason for this is now clear. The Crown, notwithstanding the provisions of the above Statute, successfully maintained the right of disposing of its own grants by constituting the Privy Council the Court before which alone the validity of patent rights could be adjudicated. In spite of the more than doubtful character of its jurisdiction, the Council proved a most competent and business-like tribunal. It never lost sight of the real object of the law. Hence proposals for instituting new industries were not allowed to drop if a suitable applicant for the

privilege was forthcoming. The rights of the native workman were carefully respected. Occasionally technical points of law were reserved to the Common Law Courts, and in exceptional cases parties were allowed to seek their legal remedy; but in only one doubtful case during this period has any decision of the Courts found its way into patent jurisprudence.

With the Hanoverian dynasty the zeal of the Council in prosecuting its industrial policy sensibly abated, and about 1750, after an unseemly squabble between Lord Mansfield and the Privy Council, the jurisdiction of the Council was allowed to lapse. Thus when the Common Law Courts resumed their jurisdiction over Letters Patent they were without precedent to guide them for a period of about a century and a half.

It was in these circumstances that the well-known doctrine of the patent specification was evolved. Interpreting the Statute of Monopolies by the contemporary meaning of its language, the Courts construed the phrase "true and first inventor" in its modern sense. This left the Statute devoid of any expressed consideration; for it invested the inventor with rights without any corresponding obligation. True, there was a clause in the Letters Patent of recent introduction which made the validity of a patent contingent upon the filing of a specification within a fixed period, but there was also an older final clause waiving a full, or indeed any, disclosure. By emphasising the former and ignoring the latter clause, Lord Mansfield laid down that the patent grant was made in consideration of the filing by the patentee of such a description of his invention as would enable a skilled artisan in the trade to work the invention. The effect of this judgment was to make the validity of patents conditional upon their compliance with an uneconomic and, from an administrative point of view, impracticable standard of novelty; for the decision involved the shifting of novelty from the practice of the trade to novelty of disclosure within the realm. By depreciating the security of the patent it lowered its commercial value —while discouraging the importation of industries not practised within the realm. As, however, no attempt was made to bring administrative practice into harmony with the legal requirements, applicants continued to obtain their patents on the old basis.

In 1905 a fifty years' search through British patent specifications came into operation. It was instituted as an instalment of a wider scheme of examination to be introduced at a future date. The effect of official examination is always to reduce the restraining power of a monopoly in a degree corresponding with the extent of the search. A representative of one of the largest patent-owning firms in the United States once said to the present writer, "Our American patents are not worth a d—n! We take them out because they are cheap!" Without applying this dictum wholesale as a criterion of the value of the patents issued by any office which examines for novelty, it is clear that the effect of official examination is to reduce a large proportion of its grants to the level of commercial advertisement. If it be alleged that the object of the above measure was to harmonise the law and practice of patents, it must be pointed out that the framers of this Act introduced at the last moment a clause to "round off" the official search by removing British patent specifications not retained on or included in the official files from the stock of public knowledge. Thus the Common Law standard was sacrificed to official convenience. In this manner the English Law of Novelty has been made to box the compass. Valid patents can now be obtained without any consideration, for the disclosure may be identical with that already disclosed and published. The latter cannot be cited as evidence of prior anticipation. Let it be granted that no public inconvenience has arisen under the operation of this clause: but this admission undercuts the whole case for official examination so far as that examination is conducted through specifications of lapsed patents. The law obviously stands in need of a clear and business-like statement of its principles. An attempt in this direction was made in the Patents Act of 1919, which explicitly reaffirms the doctrine of the old Law as to "working"; but as no concurrent relief was provided for the patentee on proof of commercial working, the value of the British patent continued on its downward path.

One step only remains to be taken to deprive our patent law of its last vestige of biological significance, namely, the abolition of protection to the importer of a new industry. This change, however, is foreshadowed in the Report of the British Empire Conference of 1922, the delegates to which suggest that this principle should be sacrificed on the altar of imperial uniformity.

Is this country so far ahead of others in its industrial lead that it can afford to discard from its armoury the competitive principle which formed the basis of its early practice, securing for it that lead which it is frittering away to-day? The period of industrial progress, which dates from 1770, was marked by a continuous and fairly parallel growth in population and patent statistics which culminated in the year 1910. In 1911–12–13 the patent statistics began to fall away, and in the same year, 1911, the rate of growth of population showed a flattening tendency which has persisted to this day. These unfavourable symptoms are not equally reflected in the corresponding statistics of other countries.

Hence a case appears to be established for an inquiry into the working of a system which, as the result of successive modifications during the last fifty years, has lost all claim to industrial value, consistency, or administrative economy. In this inquiry all considerations of international or imperial comity should be subordinated to the national interest. The services of the inventor should be competed for by offering him the widest security for his monopoly compatible with the state of the national industry. On proof of commercial working, the validity of his patent should be freed from attack by proof of prior publication within the realm, and the patent freed from the payment of further renewal fees. On these lines the law and practice could be made consistent, effective, and economical. The cost of administration would be materially reduced, delays would be avoided, and a broad claim to the invention made secure so soon as the full consideration of the patent was given by its reduction to practice. There would, no doubt, be some increase in litigation, but patent litigation is a sign of healthy progress. These are matters clearly within the control of human agency, but courage and conviction are needed to bring about the reforms. When a vacancy occurs in a university readership the stipend is fixed at a figure calculated, as Lord Bacon says, "to whistle for the ablest men out of all foreign parts." Educationists do not accept the latest thesis as a substitute for personal service. In the same way, new teachers in industry should be requisitioned to keep our manufactures abreast of foreign enterprise. A nation which aspires to maintain its place in the hierarchy of power must conform to the teaching of natural laws.

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Transcription of Russian Names.

I DO not wish to prolong the correspondence upon this subject further than to say that in their letter appearing in NATURE, October 14, p. 512, Messrs. Druce and Glazunov meet (in my opinion) none of the objections to a Czech-script transliteration of Russian pointed out in my letter (NATURE, July 15, p. 78), but merely reiterate their views,—in which, by the way, I think I could pick a number of holes were space available.

But I should prefer not being misquoted.

I did not "ask how many English people can correctly pronounce Czech letters like *č*": (for, of course, any one can pronounce that letter, *i.e.* English *ch*). I said I wondered "how many Britons would pronounce this 'c' [that is, *ts*] correctly"—if they came across it suddenly in a Czech-script transliteration of Russian. The same criticism applies to the quoted Russian х (=Czech *ch*), which would, therefore, be wrongly pronounced by the ordinary Briton as *ch* in church instead of as *ch* in loch.

As I previously pointed out, the very simple Royal Geographical Society II. system already exists in English; so why not use it? EDWARD GLEICHEN.

Royal Geographical Society, Kensington Gore, London, S.W.7, October 20.

APART from the typographical objections to a Czech transcription of Russian, which have been pointed out by Lord Edward Gleichen, there are other difficulties in its use. From Prof. Brauner's examples his does not appear to be a uniform letter-for-letter system, at all events in the treatment of Russian "soft" vowels. For example, the letter я, when initial, would presumably be transcribed *ja*, as in языкъ, *jazyk*; but if it happens to follow д, н or т, the letter *j* is dropped in the transcription and the Czech letters *ď*, *ň*, *ť*, are employed, *vide* Prof. Brauner's examples *Ťaťana*, *Ďaďa*. And how is Russian "soft" р, which is represented in the Czech language by *ř*, pronounced *rzh* (*r*+French *j*), to be transcribed? For example, is рядъ to be rendered *řád*, which gives the wrong pronunciation, or *rjad*, which is not Czech?

Again, it is not clear how Russian е and ѣ are to be treated. The natural Czech transcription would be *e* and *ě* respectively; but Prof. Brauner writes *Menděljev*, in which there are three different ways of transcribing Russian е.

The semivowel й is apparently to be transcribed *j*; but *ij*, *yj*, are not the Czech equivalents of ій, ый. Does Prof. Brauner write *Čajkovskij*? (Incidentally, the average Briton would pronounce *čaj* like *cadge*.)

Prof. Brauner would, I hope, go so far as to abandon Czech for the transcription of Russian г, and would let us write *Vinogradov*, though the true Czech would be *Vinohradov*.

Messrs. Druce and Glazunov maintain (NATURE, October 14, p. 512) that the system has the advantage of being complete; but what is the complete system? The foregoing points want clearing up.

JOHN H. REYNOLDS.

Royal Geographical Society, Kensington Gore, London, S.W.7, October 21.

Volcanic Shower in the N. Atlantic.

THROUGH the courtesy of Dr. Russell (Director) and of Mr. J. W. Carruthers, of the Fisheries Laboratory of the Ministry of Agriculture and Fisheries at Lowestoft, I am enabled to record a shower of volcanic dust that occurred near the Faroes on Thursday, October 5, soon after 5 A.M.

The captain of the steam trawler *Prince Palatine* reports that his mate directed his attention to what looked like a sudden appearance of land on the port quarter, when the vessel was about 62° 7′ N. and 7° 43′ W., Myggenæs (an islet west of Vagö) being on the starboard quarter. A heavy sandstorm soon enveloped the vessel, lasting for the extraordinary period of sixty-seven hours, during which the air resembled that of a London fog, while the vessel was covered with a deposit from stem to stern. Only a very small sample of the material is available; but Mr. Carruthers rightly concluded that it consisted of volcanic glass. With him, I note a few opaque particles; but these are in part white by reflected light, while others are merely fragments of deeply coloured glass. The material is a characteristic dust of volcanic glass, distinctly brown, and probably andesitic or basaltic. I can trace no crystals; some of the particles show twisted wisp-like forms, and the majority are comminuted pumice, resulting from attrition in the air of masses in which the volume of vesicles exceeded that of glass. Branching forms, like spicules of lithistid sponges, are thus common. Mr. Carruthers informs me that the Meteorological Office record shows that the position of the fall lay in a cyclonic depression, with a wind from somewhat east of south, blowing at 17 miles an hour.

The duration of the fall may possibly be due to a circling round of some of the material. Its occurrence seems worth recording, for comparison with dust that may have fallen on other ships at the same date. Some account may be forthcoming from the northern isles of the Faroe group. It is most probable that the source was an eruption in Iceland, the dust having in that case travelled about 500 miles. The fine glassy dust has no doubt become sifted out from coarser matter during transit.

GRENVILLE A. J. COLE.

Carrickmines, Co. Dublin, October 21.

Orientation of Molecules in a Magnetic Field.

ABOUT this time last year, at the suggestion of Prof. A. W. Stewart, I began some work to test whether or not the molecules of a substance (more particularly at first of a liquid) underwent an orientation when placed in a magnetic field. So far the results all seem to indicate that something of the kind does take place. The method first adopted was analogous to Laue's method of diffracting X-rays. A parallel pencil of X-rays was directed through a small cell containing barium iodide placed between the poles of a large electro-magnet, and was then received on a photographic plate. During the first complete exposure no current was run through, during the next current was run through, and the process was repeated with a second pair of plates. In the case of both pairs of plates it was found that the disc which came up dark on development was greater in diameter for the exposure during which the magnet had been excited than for that when it had not been excited. The increase was more than ten per cent. of the original diameter. This effect may be analogous to that observed when a pencil of X-rays is passed through a powdered crystal. So far this method has not been used in a very refined manner, but it is hoped to continue with it and to improve it. The results obtained by it, however, have been corroborated by entirely independent methods, in which the properties of X-rays were not made use of.

The question of the nature of the orientation, in addition to that of its occurrence, is still under investigation here, and I hope to be able shortly to make a further communication on this subject, giving more detail as to both the results obtained and the methods employed. MARSHALL HOLMES.

The Sir Donald Currie Laboratories, Queen's University, Belfast, October 10.

The Ramsay Memorial in Westminster Abbey.

It is a somewhat inhuman trait among British men of science, and in particular among chemists, that they have not sufficiently secured public honour for their fathers who spiritually begat them. Boyle's resting-place is unknown, and there is no express memorial to him in the Royal Society, of which he was the greatest founder; and to the chief of his chemical successors, however well remembered in the records of their science; tangible monuments for the most part exist only where purely local pride has preserved or erected them. The ceremony of November 3, therefore, when a medallion tablet in memory of Sir William Ramsay was unveiled in Westminster Abbey, was a most welcome manifestation of a world-wide tribute.

The British nation at large was represented in the person of H.R.H. the Duke of York (the Prince of Wales being prevented by a riding mishap); Sir Charles Sherrington, president of the Royal Society, stood for British science, together with a large gathering which included many of its foremost followers; Prof. Le Chatelier came from Paris as president of the Academy of Sciences; while the presence of the ambassadors and ministers of no fewer than twenty-one countries attested the far-reaching fame of Ramsay's achievements. Lady Ramsay was present, with Mr. W. G. Ramsay, and Dr. and Mrs. H. L. Tidy and their children. A short choral service was held in the nave, during which the Duke of York unveiled the tablet and offered it to the Dean, who in dedicating it referred to the panels commemorative of Joule, Kelvin, Hooker, Darwin, and Lister, among which it is to be permanently set. The medallion was provided from the Ramsay Memorial Fund.

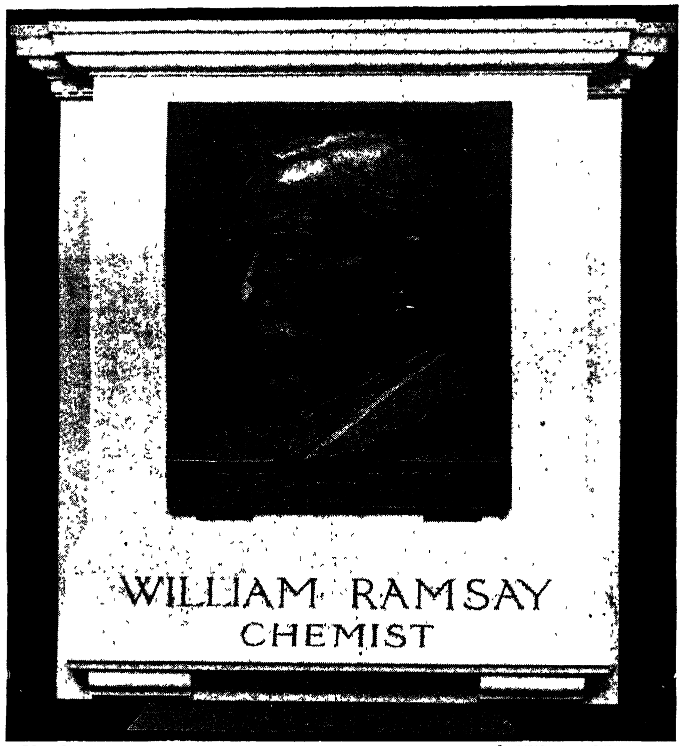

Photo.] [*Elliott and Fry, Ltd.*

FIG. 1.—The Ramsay Memorial, Westminster Abbey.

This fund, begun in 1917, consists of nearly 58,000*l.* raised by private subscription all over the world; and the capitalised value of the additional endowments by Dominion and foreign governments is as much again. Eleven Ramsay Fellowships, each of annual value at least 300*l.*, enable promising research-students to come to carry on work in any selected chemical laboratory in Britain, from Canada, France, Switzerland, Greece, Italy, Norway, Sweden, Denmark, Spain, Holland, and Japan; and there are also British Ramsay Fellowships, including one specially connected with Glasgow, Ramsay's *alma mater*. From the remainder of the fund, 25,000*l.* is being devoted to a laboratory of chemical engineering at University College, London, where Ramsay taught and worked for 26 years; there, also, an annual Ramsay medal has been founded.

The Abbey bronze, which was executed by Mr. C. L. Hartwell, A.R.A., is illustrated in the accompanying photograph (Fig. 1). The artist has been compelled, owing to the nature of the only position available in the Abbey, to give to the eyes a downcast expression which in life they rarely assumed. Probably no medium could convey the inward and outward sparkle which lit Ramsay's eyes under their characteristically lifted brows; and his open glance and the quick charm of his smile defy portrayal.

As a chemist, Ramsay had three great gifts in nearly equal degree: boldness of imagination, amazing audacity in conceiving experiments, and extraordinary constructional and manipulative deftness in carrying them out. Of his earlier researches the importance is exemplified by his discovery of the nature of Brownian movement, by the work embodied in the Ramsay-Young equation, and by that which gave the Ramsay-Eötvös method for measuring molecular association in liquids. In 1894, he alone of chemists had the courage to see in Rayleigh's abnormal nitrogen-densities the indication of a new atmospheric element and to seek it and find it; his discovery of helium came as a dramatic reward for a search after further sources of argon; and with the advent of liquid air he, with Travers, drove on with irresistible impetus to the detection and isolation of neon, krypton, and xenon. Only Berzelius has discovered as many new elements; no one but Ramsay has laid bare a complete and unforeseen group. In radioactivity he found fresh scope; and the experimental proof that helium is generated during radioactive change founded the era of the transmutation of elements. Possibly the finest example of his skill was given when, with Whytlaw-Gray, he measured the density of one-thousandth of a milligram of gaseous radium-emanation—the last member of his own group of inert gases.

Like Priestley and Davy, Ramsay opened up a new world for science; and physics, chemistry, and even astronomy are enriched, not alone by the discoveries which he made, but also by the methods which he devised and so freely handed on to others. I. M.

S. P. Langley's Pioneer Work in Aviation.[1]

By Prof. L. Bairstow, C.B.E., F.R.S.

The work of Prof. S. P. Langley in aviation is such a first-rate example of systematic inquiry—of a type rightly called scientific—that no excuse is needed in again directing attention to it. Progress was made step-by-step in the face of formidable difficulties, and no attempts were made to solve the problems of mechanical flight by bursts of brilliance or invention. The scientific method appears to be most suitable for the great bulk of human endeavour and is required in the interpretation and development of striking innovations.

Langley was a creative investigator and not merely a producer of data. It is probably not wide of the mark to say that his experimental results are now rarely appealed to, yet who can doubt that the whole course of aviation was largely determined by his efforts? Langley's work may be divided into two periods—1887 to 1896, and 1896 to 1903. The end of this period is almost coincident with the earliest successes of the Wright Brothers. The later Hammondsport trials on a modified Langley aeroplane have obscured the real issue, and it is better to leave these out of account as having nothing to do with Langley and his methods.

The story can be readily told in extracts from the originals; in 1901 Langley said:

"And now, it may be asked, what has been done? This has been done: a 'flying machine,' so long a type for ridicule, has really flown; it has demonstrated its practicability in the only satisfactory way—by actually flying—and by doing this again and again under conditions which leave no doubt.

"There is no room here to enter on the consideration of the construction of larger machines, or to offer the reasons for believing that they may be built to remain for days in the air, or to travel at speeds higher than any with which we are familiar. Neither is there room to enter on a consideration of their commercial value, or those applications which will probably first come in the arts of war rather than those of peace; but we may at least see that these may be such as to change the whole conditions of warfare, when each of two opposing hosts will have its every movement known to the other, when no lines of fortification will keep out the foe, and when the difficulties of defending a country against an attacking enemy in the air will be such that we may hope that this will hasten rather than retard the coming of the day when war shall cease."

This note was written before the advent of the man-carrying aeroplane—two years before. Some of the prediction is yet unfulfilled, particularly that as to remaining for days in the air, but it accurately anticipated war uses before civil. In continuing his story Langley shows that he had no commercial interests in his efforts:

"I have thus far had only a purely scientific interest in the results of these labours. Perhaps if it could have been foreseen at the outset how much labor there was to be, how much of life would be given to it and how much care, I might have hesitated to enter upon it at all. And now reward must be looked for, if reward there be, in the knowledge that I have done the best in a difficult task, with results which it may be hoped will be useful to others. I have brought to a close the portion of the work which seemed to be specially mine—the demonstration of the practicability of mechanical flight—and for the next stage, which is the commercial and practical development of the idea, it is probable that the world may look to others. The world, indeed, will be supine if it do not realise that a new possibility has come to it, and that the great universal highway overhead is now soon to be opened."

This passage is of extreme interest; it emphasises the scientific spirit and the relation of science to industry. Monetary reward did not come to Langley, nor did the merits of his work save him from biting criticism in the press on the failure of his man-carrying aeroplane. Time has probably enabled us to take a more detached and fairer view. These early remarks by Langley prepare us for a note by his assistant, Mr. Manly:

"In the spring of 1904 after the repairs to the main frame were well under way, the writer [Mr. Manly] on his own initiative undertook to see what could be done towards securing for Mr. Langley's disposal the small financial assistance necessary to continue the work; but he found that while a number of men of means were willing to assist in the development of the aerodrome [aeroplane] provided arrangements were made for later commercialisation, yet none were ready to render assistance from a desire to assist in the prosecution of scientific work." On the other hand, Langley "had given his time and his best labours to the world without remuneration, and he could not bring himself at his stage of life to consent to capitalise his scientific work."

The problem of financing and directing scientific research is seen here as a striking example of the failure of our systems. The troubles still exist in large measure, and much has yet to be learnt before science and industry combine for efficiency and economy. The relation caused comment by Manly to the effect that:

"Persons who care only for the accomplished fact may be inclined to underrate the interest and value of this record [1911]. But even they may be reminded that but for such patient and unremitting devotion as is here enregistered, the new accomplished fact of mechanical flight would still remain the wild unrealised dream which it was for so many centuries."

Throughout his writings, Langley made a clear distinction between two subjects which he called "aerodynamics" and "aerodromics"—a distinction which still exists but is differently described. His division corresponds very closely with the modern expressions "performance" and "control and stability," both being now regarded as branches of aerodynamics. The scientific advisers of the Air Ministry are more and more turning to the study of "aerodromics," on which progress towards safety in flying is seen largely to depend. Its problems are still very difficult. In concluding this note probably the best summary is Langley's own:

"I am not prepared to say that the relations of power, area, weight, and speed, here experimentally established for planes of small area, will hold for indefinitely large ones; but from all the circumstances

[1] Extracted from an address delivered as chairman of the Royal Aeronautical Society on October 5.

of experiment, I can entertain no doubt that they do so hold far enough to afford assurance that we can transport (with fuel for a considerable journey and at speeds high enough to make us independent of ordinary winds) weights many times greater than that of a man." And

" I desire to add as a final caution, that I have not asserted that planes such as are here employed in experiment, or even that planes of any kind are the best forms to use in mechanical flight, and that I have also not asserted, without qualification, that mechanical flight is practically possible, since this involves questions as to the method of constructing the mechanism, of securing its safe ascent and descent, and also of securing the indispensable condition for the economic use of the power I have shown to be at our disposal—the condition, I mean, of our ability to guide it in the desired horizontal direction during transport,—questions which, in my opinion, are only to be answered by further experiment, and which belong to the inchoate art or science of aerodromics, on which I do not enter."

The problems of Langley are still problems, and we have very much to learn about the control of aeroplanes. An interesting commentary on Langley's work is provided by the fact that on October 19 the world's record for gliding flight was obtained on a replica of the Langley machine and not by a glider following the modern conventional aeroplane. It would be wrong, I think, to argue superiority of type for the successful glider, but it is a not unwelcome reminder of the enormous progress made by a scientific pioneer at a time when science in aviation is at a very low ebb.

The Early History of the Land Flora.[1]

By Dr. D. H. Scott, F.R.S.

II.

When we reach the Upper Devonian flora we find ourselves in the midst of a comparatively familiar vegetation. A few of the early forms may have survived, but the bulk of the plants were highly organised Vascular Cryptogams or Spermophytes. While in the Early Devonian no true Ferns have been found, a branched, naked rachis being the nearest approach to a frond, the later vegetation has been called the Archæopteris flora, after the magnificent ferns or fern-like plants of that genus, of which the famous *A. hibernica* is the type. We do not, however, know for certain whether these fine plants were really Ferns, or fern-like seed-plants. The presence of true Ferns is more surely attested by Dawson's Asteropteris, from the State of New York, which has the structure of a Zygopterid, a group well known from Carboniferous rocks. Lycopods had attained a very high development, as shown especially by the genus Bothrodendron, of which the large heterosporous cones are known.

The now extinct group of the Sphenophyllums, characteristic of Carboniferous times, had also made its appearance in the Upper Devonian flora; the whorled leaves of these early forms were deeply cut, not wedge-shaped as in most of the later representatives. Nathorst's genus Hyenia, which already appears in the Middle Devonian, may probably have been a precursor of the Sphenophylls.

Another family, represented by Pseudobornia, of Nathorst, from Bear Island, is only known from the Upper Devonian. It was a large plant, with whorled leaves, palmately divided, and further cut into narrow segments, while the long cones are believed to have produced spores of two kinds. Pseudobornia is at present quite isolated; its affinities may be either with the Sphenophylls or the Horsetails. Apart from this case, the Equisetales do not appear to be represented among our present Devonian records, for the evidence for the occurrence of Archæocalamites at that period seems to be inadequate. The group, however, was so well developed in Lower Carboniferous times that there can be no doubt it had appeared long before.

The best proof of the presence of seed-plants in the Upper Devonian is to be found in the occurrence of petrified stems, which, from their organisation, must presumably have belonged to advanced Gymnosperms. The genus Callixylon, apparently allied to the Lower Carboniferous Pitys, has a peculiar and beautiful structure in the secondary wood, the pits being localised in definite groups. The wood appears more highly differentiated than that of most living Conifers.

Thus the main lines of subsequent evolution were already well laid down in Upper Devonian times. We know practically nothing of their origin. Some botanists believe that the higher plants may have had a common source in some group, already vascular, such as the Psilophytales, while others hold that the main phyla have always been distinct, from the Algal stage onwards. The existence of these rival monophyletic and polyphyletic hypotheses, both maintained by able protagonists, shows how little definite knowledge of the evolutionary history we possess.

The Lower Carboniferous flora bears a close general resemblance to the Upper Devonian, but is much better known. The wealth of forms is, indeed, so great, that only the merest outline of the main features can be given here.

The Lycopods were abundantly developed. Many species of Lepidodendron and Lepidophloios are known, not only by external characters, but often by anatomical structure. While the primary ground plan of their anatomy was not unlike that of some of the simpler Lycopods of our own day, most of the old forms developed a considerable zone of secondary wood, and a massive periderm. They were, in fact, adapted to play the part of forest trees. The genus Sigillaria, however, so important in the Upper Carboniferous flora, was still scantily represented.

As regards their fructification, the Lower Carboniferous Lycopods had attained the highest level which the class ever reached. Not only were their cones constantly (so far as observed) heterosporous, with an extreme differentiation of the two kinds of spore, but some of them even developed a kind of seed, a structure quite unknown among Club-mosses of later than Carboniferous age. In the seed-like fructification

[1] Continued from p. 607.

(Lepidocarpon) a single megaspore only came to maturity, constituting the embryo-sac, while an integument, like a seed-coat, grew up round the sporangium.

The prothallus is sometimes well preserved, both in the seed-like bodies and in the more ordinary megaspores. In the latter (*Lepidostrobus Veltheimianus*), Dr. Gordon has recorded a perfectly typical archegonium, showing that the details of reproduction in these old Lycopods were the same as in their modern heterosporous representatives.

The best-known member of the Horsetail race was Archæocalamites, remarkable for the long leaves, often repeatedly forked, very different from the foliage which we are accustomed to associate with the Equisetales. The later Calamites were more or less intermediate in this respect. Anatomically, the Calamites, whether of Lower or Upper Carboniferous age, developed much secondary wood, and, like many contemporary Lycopods, became trees. The Lower Carboniferous Protocalamites is remarkable for possessing primary wood, centripetally formed, thus presenting some analogy with the Sphenophylls, in which this tissue is highly developed.

The cones attributed to Archæocalamites are, curiously enough, intermediate in structure between modern Equisetum cones and those of the Upper Carboniferous Calamites, for sterile bracts were either absent, or developed only at long intervals. In Equisetum, of course, they are absent altogether, while in the well-known Calamostachys and allied Upper Carboniferous fructifications, the sterile whorls are equal in number to the alternating fertile verticils. It must be admitted, however, that our knowledge of Lower Carboniferous fructifications of this group is still somewhat scanty.

The Sphenophylls of the period were already very advanced, and in the genus Cheirostrobus appear to have reached their zenith. The great cones of this striking plant, with their elaborate and perfect apparatus of compound sporangium-bearing organs, and protective sterile appendages, are certainly the most complex cryptogamic fructifications known, from any period. Thus, in certain directions, the Lower Carboniferous plants had attained a height of development which has never since been equalled.

Sphenophyllum itself still had, for the most part, the deeply cut leaves of the Upper Devonian species. Where the anatomy is known (*S. insigne*, from Burntisland), it is of the same general type as in the later Upper Carboniferous forms, but apparently somewhat less specialised. It is worth remarking, that all the Sphenophyllums formed secondary wood, though they were small plants. Thus growth in thickness by cambium was not confined to arborescent forms in Palæozoic times, any more than it is now.

As regards the affinities of the Sphenophylls, some relation to the Horsetail stock seems evident, as indicated by the whorled leaves, the general organisation of the cones, and the detailed structure of the sporangia. Presumably these two lines sprang from a common source, but what it was is still unknown. Further affinities, once suggested, with the Lycopods and the recent Psilotaceæ have not been confirmed and are probably illusory. Neither has Lignier's hypothesis of a common origin of both branches of the Articulatæ from Ferns, gained any support from the fossil record. The Articulatæ, as a whole, remain a completely isolated phylum.

The Ferns of the Lower Carboniferous were well developed and varied. We meet with the usual difficulty in distinguishing between the fronds of true Ferns, and those of the so-called "Seed-Ferns," which simulated them in habit. Where, however, anatomical characters are available, we find no approximation whatever between the two groups. Pteridosperms and Ferns at all times show themselves perfectly distinct, whenever our knowledge admits of an adequate comparison.

We have fairly abundant structural material of Lower Carboniferous Ferns, but it seems that practically all of it represents the group called Primofilices by Arber, who by this name meant to suggest age, not primitiveness. They were curious plants, and many of them must have been very unlike any Ferns now living. Unfortunately, our knowledge of their habit is by no means equal to that of anatomical detail.

The chief family in the Lower Carboniferous is that of the Zygopterids, of which several genera are represented. As we have seen, this family had already appeared in Upper Devonian times. The vascular cylinder of the stem shows some differentiation of the wood into a central region (either a mixed pith or a core of small, short tracheids), and a wide outer zone of larger elements. The petiole always has a peculiar structure, with a bilateral strand (often of complex form) giving off branch-bundles to the right and left. It is remarkable that the genus Clepsydropsis, once thought primitive on account of its simple petiolar structure, has been shown to possess an exceptionally high organisation of the stem.

The most striking point is the morphology of the frond. Even where there were only two series of pinnæ (as in normal compound leaves) their plane was not parallel to that of the main rachis, but at right angles to it. Moreover, in several genera there was the greater peculiarity that the pinnæ were in four rows, two rows on each side, a condition unexampled in ordinary leaves. In Stauropteris this quadriseriate branching was repeated in successive ramifications, so that the form of the whole frond was compared by Lignier to a bush. In this genus it is practically certain that the leaflets had no blade, and throughout the family there is rarely any proof of its presence.

The other Lower Carboniferous family of Primofilices, the Botryopterideæ, is at present represented for that period by a single species, the *Botryopteris antiqua* of Kidston, a plant in all respects of simpler organisation than the Zygopterids, and apparently more like an ordinary Fern.

Sporangia are known in several cases. Those of Stauropteris were borne singly on ultimate branches of the frond; they had no annulus, and are very similar to the sporangia associated with the Early Devonian Asteroxylon. In the fructification attributed to Diplolabis the sporangia are grouped in a sort of synangium, while those associated with Botryopteris have a biseriate annulus.

Both families show some affinity with the older members of the Osmundaceæ, while a relation to the Adder's Tongues has also been traced. But in both directions the connexion seems to be somewhat remote.

We are dealing, in the Lower Carboniferous Primofilices, with early races, already specialised on their own lines, and probably only indirectly connected with the main current of Fern-evolution.

The "Seed-Ferns" or Pteridosperms appear to have attained a great development in Lower Carboniferous times. A considerable variety of seeds is met with, and in some cases there is strong evidence for attributing them to plants with a fern-like foliage. In one such example, described by Nathorst, the seed (Thysanotesta) is remarkable for having a distinct pappus; it was thus adapted to wind-dispersal, like the achenes of Composites.

No less than six families, referred to Pteridosperms, are known by their anatomy. In only one is there any evidence as to the seed, but all these groups show, in their structure, a nearer relation to known "Seed-Ferns" than to any other phylum. The case referred to is that of Heterangium, a genus with a solid wood and no pith. A beautifully organised seed (Sphærostoma, Benson), obviously related to that of the Upper Carboniferous Lyginopteris, is found in close association with *Heterangium Grievii* and probably belonged to it. The two genera, Heterangium and Lyginopteris, are closely related, as shown by Dr. Kubart's discovery of intermediate anatomical features, in species of Millstone Grit age.

The Lyginopterideæ extend to the Upper Carboniferous, but the other five anatomical groups are peculiar to the Lower.[1] They show a great variety in structure, but none of them bear any anatomical resemblance to contemporary Ferns. Our knowledge of so many, more or less isolated, types indicates that we have only found a few relics of what was really a most extensive class of plants.

The family most richly represented is that of which Calamopitys is the type. A number of species of Calamopitys are known; they are plants with a pith (sometimes "mixed"), large leaf-trace bundles, and much secondary wood. The petioles, often of large size and with many vascular strands, have long been known as Kalymma. Some of the species, with dense secondary wood of a Coniferous type, have been separated by Dr. Zalessky under the name Eristophyton. An interesting new genus, Bilignea, in which the pith is replaced by a central column of short tracheids, has been discovered by Dr. Kidston.

[1] Space does not admit of any account of their remarkable characters. The five type-genera are: Rhetinangium, Stenomyelon, Protopitys, Cladoxylon and Calamopitys.

Apart from the "Seed-Ferns," we have the remarkable Lower Carboniferous family of the Pityeæ, already represented, as we have seen, in the Upper Devonian. Pitys was a genus of trees, with a relatively large pith traversed by slender strands of wood, while the secondary wood was of an Araucarian type. The foliage was quite unknown until recently, when Dr. Gordon discovered the leaves attached to the twigs in a species from the shores of the Firth of Forth. The leaves are totally different both from those of any Pteridosperm and from the well-known foliage of the Upper Carboniferous Cordaiteæ; they rather resemble the needles of a Fir, though more complex in structure. Dr. Gordon suspects an affinity with Araucarian Conifers.

Perhaps the chief conclusion that follows from this hasty sketch of the earlier floras is the great distinctness of the main phyla.

The Lycopods may perhaps become merged, as we trace them back, in the early Devonian Psilophytales, but nowhere approach any other group.

The Articulatæ appear as an isolated phylum throughout.

The Ferns may have come from thalloid plants, through some of the forms of Early Devonian age, where the frond is only represented by a bladeless rachis. The "Seed Ferns" now appear as a totally distinct line, parallel in certain respects to the true Ferns, but nowhere joining them, unless it be in some common thalloid source, about the Psilophytales level.

The higher Gymnosperms, represented in the period considered by Pitys and its allies, may have passed through an earlier Pteridosperm stage, but this is not proven. The Spermophyta generally may, for all we know, be as ancient as any other vascular plants.

Thus phylogeny still eludes us, though it remains the ultimate goal of the palæontologist.

Obituary.

Dr. C. G. Knott, F.R.S.

THE sudden death of Dr. C. G. Knott, reader in applied mathematics in the University of Edinburgh, and general secretary of the Royal Society of Edinburgh, has deprived physical science of a devoted follower and an accomplished exponent. On Wednesday, October 25, he was lecturing as usual and attending, in the afternoon, to the business of the Royal Society. At night he was taken ill and died of heart failure in a few hours.

Born at Penicuik in 1856, Knott entered the University of Edinburgh in 1872 and soon joined a little band of enthusiastic workers in the laboratory of Prof. Tait. To study under that great teacher was a privilege and an inspiration. The laboratory, then a new feature in university physics, was a small attic, meagrely equipped. Only a few of the best pupils cared to seek admission; they plunged at once into research, either sharing in the investigations on which Tait happened to be engaged, or undertaking some independent inquiry of their own. Tait was then collecting data for his thermoelectric diagram, and Knott's training was to measure the electromotive forces between pairs of some twenty different metals, through a wide range of junction temperatures. He also began the series of magnetic researches he was afterwards to pursue with the help of his own Japanese pupils. In 1879 he was appointed Tait's assistant, but gave up that post in 1883 when he became professor of physics in the University of Tokyo. After eight years as professor in Japan he returned, in 1891, to his own University of Edinburgh, where he spent the rest of his life, at first as lecturer and later as reader in applied mathematics. He also acted as the official adviser of students reading for honours in mathematics

and physics, or for degrees in science—a task which his wide knowledge, his unfailing good nature, his geniality, his ready sympathy, and his infinite capacity for taking pains, fitted him to discharge to the great advantage of many generations of undergraduates. For the last ten years he also held the office of general secretary in the Royal Society of Edinburgh, where the same characteristics found further exercise, along with others which eminently qualified him for editorial work.

In Japan, with pupils such as Nagaoka, Knott's influence as a teacher soon became conspicuous, and has proved enduring. His love of research was infectious. The school of young Japanese seismologists and magneticians, then in its infancy, owed much to his example and encouragement. Along with Tanakadate, he carried out a magnetic survey of "all Japan." His industry was untiring and the habit of research, formed in his student days, never left him. All his scientific work is sound and thorough. His published papers, more than seventy in number, cover a wide range, but the subjects of ferro-magnetism, especially in its relation to strains, and of seismology, continued to engage his main attention. His book on the physics of earthquake phenomena, published in 1908, is an admirable digest of the whole subject, linking up the older with the newer seismology. His last long paper, published by the Royal Society of Edinburgh in 1919, completed a series in which the theory of earthquake-wave propagation is discussed with much originality.

Probably the best known of Knott's books is his Biography of Tait (Camb. Univ. Press, 1911). No other disciple was so fit to undertake the difficult task of writing the life of the master, for on Knott the mantle had most directly fallen, and he, more than any, continued to wear it. Tait himself, in a preface to his collected papers, speaks of Knott as an adept in quaternions as well as in physics, and adepts in quaternions have always been rare. Knott's grasp of mathematical methods, his intimacy with Tait's work and appreciation of Tait's genius, and above all his affectionate comprehension of an often whimsical personality, inspired him to write what is beyond question an exceptionally adequate and deeply interesting biography. More recently he organised the Napier tercentenary (1914), and edited the memorial volume. Almost his last act was to pass for the press the final sheets of collected papers by the late Dr. John Aitken, F.R.S.

An unselfish, modest, Christian gentleman, whose life was a constant round of unobtrusive service, Knott is mourned by many friends. J. A. E.

BY the death of Thomas Francis Moore the National Museum, Melbourne, has lost one of the most valued members of its staff. Mr. Moore had filled the position of osteologist at that institution for nearly twenty-two years. His work was of a very high order and universally known. As a link with the past, it may be mentioned that Mr. Moore's father, Mr. T. J. Moore, was for forty years curator of the Liverpool Museum, and from 1865 to 1884 organised and took part in the Liverpool Free Public lectures. Dr. Frederick Moore, of the East India Company's Museum, well known by his work on oriental Lepidoptera, was an uncle of Mr. T. F. Moore.

THE *Chemiker Zeitung* of October 17 reports the death, at the age of sixty-four years, of Prof. Lassar-Cohn, who had occupied the chair of chemistry at Königsberg since 1894. His work was mainly in the fields of organic and technical chemistry, and his text-books were well known in English translations.

Current Topics and Events.

THE following is a list of those recommended by the president and council of the Royal Society for election to the council at the anniversary meeting on November 30:—*President*: Sir Charles Sherrington; *Treasurer*: Sir David Prain; *Secretaries*: Mr. W. B. Hardy and Dr. J. H. Jeans; *Foreign Secretary*: Sir Arthur Schuster; *Other members of Council*: Prof. V. H. Blackman, Prof. H. C. H. Carpenter, Prof. T. R. Elliott, Prof. A. Harden, Sir Sidney Harmer, Prof. W. M. Hicks, Prof. H. F. Newall, Prof. G. H. F. Nuttall, Prof. D. Noel Paton, Lord Rayleigh, Prof. O. W. Richardson, Sir Ernest Rutherford, Dr. Alexander Scott, Mr. F. E. Smith, Sir Aubrey Strahan, and Prof. J. T. Wilson.

IT is announced in *Science* that Dr. S. W. Stratton, director of the Bureau of Standards at Washington for the past twenty-one years, has been elected president of the Massachusetts Institute of Technology. Dr. Stratton was professor of physics and electrical engineering at the University of Illinois and professor of physics at the University of Chicago before his appointment as director of the Bureau of Standards in 1901; he found the department a small office employing three or four people, and from it he built up the present department with a staff of about 900. Commenting on Dr. Stratton's resignation, Mr. Hoover is reported by the *New York Times* to have said: "The Massachusetts Institute of Technology, an educational institution, finds no difficulty in paying a man of Dr. Stratton's calibre three times the salary the government is able to pay him." It appears that it is impossible to live and to provide for old age while at Washington on a government salary, and for this reason it is difficult to induce men of science to undertake responsible national posts.

PROF. A. SMITHELLS' retirement at the end of the present session from the chair of chemistry of the University of Leeds, after thirty-eight years of active work, will be a serious loss to the whole educational world as well as to the narrower sphere of academic life of the University in the progress and development of which he has played so conspicuous and devoted a part. His intention in retiring is to employ part

of his leisure in literary and scientific work with which his present multifarious duties, not only as head of a very large and busy department, but also as member of numerous university committees and outside public bodies, seriously interfere.

THE use of the cinema as a means of agricultural education among farmers is in contemplation in this country, and at least one organisation is understood to be preparing a set of films. A recent announcement in *Le Matin* indicates that France may, however, be first in the field. It is stated that the Ministry of Agriculture has submitted to the President of the Republic an order authorising an annual grant of 500,000 francs for the purpose of installing, in agricultural colleges and schools and in the rural communes, cinematographic appliances which would be used for the popularisation of scientific agriculture. There is no question that the cinematograph could serve a highly useful purpose; it is not only more attractive than the lantern slide, but it brings out points that could not otherwise be readily shown. It may be doubted whether the ordinary lantern slide could be dispensed with, however, and the lecturer of the future will probably try to use both films and slides.

AT the International Congress of Eugenics held in New York in 1921 an International Commission of Eugenics was re-formed from a previously existing committee. This committee held its first annual meeting at Brussels on October 7 and 9. By a unanimous vote it was decided to invite Germany to co-operate in its labours in the future, delegates from the United States, France, Denmark, Holland, Norway, together with Major Darwin, the chairman, and Dr. Govaerts of Belgium, the secretary, being present. The Société Belge d'Eugenique held a series of conferences at the same time, at which interesting papers were read. This society is to be congratulated on the assistance it is now receiving from the Solvay Institute, both as regards quarters and funds.

UPWARDS of eighty members and visitors attended the last conversazione of the Natural History Museum Staff Association for the current year, which was held in the Board Room on November 1. Among the many interesting exhibits placed round the room may be mentioned the following: A selection of birds collected in the course of the Shackleton-Rowett Expedition to the Antarctic regions by the *Quest*; life-size casts of the dolphins recently received by the Museum from Tung Ting Lake, China, about 800 miles from the sea; a series of specimens illustrating sporadic variation in plaice and flounder; life-size models in colour of toads and frogs shortly to be placed in the exhibition gallery; enlarged model of an extinct marine arthropod found in the Upper Silesian rocks of Oesel in the Baltic; examples of tropical spiders which have been discovered alive in this country; a selection of the butterflies collected in the course of the Mount Everest Expedition 1922, and a small fragment of the rock (biotite-schist) at the highest point reached by the climbing party; diagrams of genera of British Carboniferous corals, and others illustrating the distribution of mammals in Africa; and specimens illustrating the introduction of the chrysanthemum into this country in the eighteenth century. In addition, Mr. O. H. Little showed beaded casts of crustacean or worm tracks from the Nubian sandstone at Wady Arabah, Egypt. Messrs. James Swift and Son exhibited recent models of their microscopes and accessories, and Messrs. Baird and Tatlock showed examples of glassware and other apparatus for museum and laboratory use.

THE Society of Chemical Industry, which was founded in 1881 for the promotion of applied chemistry and chemical engineering, has now a roll of some 5500 members scattered over all parts of the world. No less than eighteen local sections have been formed at home and abroad, each section having its own officers and programme, and leading to some extent an independent existence. There is also a chemical engineering group, which has its headquarters in London. The Edinburgh and East of Scotland section has included in its programme an address by Prof. G. Barger on some recent advances in biochemistry and another by Prof. H. S. Allen on modern theories of the structure of the atom, the latter being a joint meeting with the Glasgow section, the Royal Scottish Society of Arts, and the local section of the Institute of Chemistry. The programme of the Liverpool section is more industrial; papers have been arranged dealing with bleaching agents for textiles and paper pulp, chemical industry during the war in Great Britain and France, saponification of fatty oils, patent fuels, synthetic tannins, fractional distillation, and sulphur. These two programmes are wide and varied in their appeals, and serve to show the range of the society's activities.

THE report of the council of the North-East Coast Institution of Engineers and Shipbuilders for the year 1921–22, which has recently been issued, marks the close of the thirty-eighth session of the society. In addition to the presidential address by Sir William J. Noble, thirteen papers were presented at meetings during the session, and twelve are printed in the Transactions. They cover a wide field, there being three papers dealing with naval architecture, three with internal combustion engines, two with electrical and two with mechanical engineering, in addition to a paper on casualties at sea and another on standardisation. The roll of the society in July contained 1594 names, of which 486 were those of members, 542 of associate members, and 388 of graduates. The society benefited by two gifts of 500*l.* during the year; one was from Mr. A. E. Doxford, a past president, for the endowment fund, and the other from the Furness Shipbuilding Co., Ltd., to provide an income for the newly formed Middlesborough branch. The Graduate Section had a successful session, including, in addition to its formal meetings, a number of visits to works. Study circles inaugurated in 1920, specialising in the internal combustion engine and strength of ships, continued to meet. A

programme of the papers to be read and the works' inspections arranged for the Graduate Section during the current session has been issued and gives promise of an interesting and instructive series of meetings.

THE tenth annual meeting of the Indian Science Congress, under the auspices of the Asiatic Society of Bengal, will be held at Lucknow on January 8–13, 1923. The congress will be opened by Sir Spencer Harcourt Butler, Governor of the United Provinces, who has consented to be patron. The president of the congress is Sir M. Visvesvaraya, and the presidents of the sections are as follows: Agriculture—Dr. Kunjan Pillai, Trivandrum; Physics—Dr. S. K. Banerji, director of the Observatory, Colaba, Bombay; Chemistry—Dr. A. N. Meldrum, Royal Institute, Bombay; Botany—Mrs. Howard, Pusa; Zoology—Prof. G. Matthai, Government College, Lahore; Geology—Dr. Pascoe, Indian Museum, Calcutta; Medical Research—Lt.-Col. Sprawson, Lucknow; Anthropology—Dr. J. J. Modi, Bombay. In addition to the regular programme of the meetings of the scientific sections, a series of general scientific discussions has been organised, beginning with one on colloids by Dr. S. S. Bhatnagar, of Benares. A series of illustrated public lectures on subjects of popular scientific interest has also been arranged, details of which will be announced later. Further particulars regarding the congress may be obtained from Dr. C. V. Raman, general secretary, Indian Science Congress, 210 Bowbazaar Street, Calcutta. The local secretaries at Lucknow are Prof. P. S. MacMahon and Dr. Wali Muhammad of the Lucknow University.

THE British Non-ferrous Metals Research Association has just issued a statement as to the investigations already in hand and the work being undertaken by the Association. The record is one of active work, and is to be commended to other Research Associations as a model to be imitated. The practice has been to allot the investigations to existing laboratories of sufficient standing, the work being carried out under the direction of the chief of the laboratory in consultation with the Director of Research, Dr. R. S. Hutton. The subjects in which progress has already been made are: effect of small quantities of impurities on the properties of copper; conditions of obtaining sound ingots of brass; methods of jointing metals; abrasion and polishing of metals; atmospheric corrosion; properties of rolled nickel-silvers; influence of oxide on aluminium; and cause of red stains on finished brass. Information has also been collected respecting the electric melting of non-ferrous metals. In regard to the first of the subjects mentioned, the effect of oxygen on copper has been studied in detail and the effect of other elements is now being examined. The laboratories with which arrangements have been made include the National Physical Laboratory; the Universities of Birmingham, Sheffield, and Manchester; the Research Department, Woolwich; the Royal School of Mines, and the Research Department of Metropolitan Vickers, Ltd. The pamphlet also contains particulars of the means adopted for circulating information among members, and concludes with an outline of the future work proposed for the Association.

A STATE Institute of Radiology has been established at Prague, under the direction of Dr. Felix.

IN consequence of the great demand for seats at the joint meeting of the Royal Geographical Society and Alpine Club for the Mount Everest film lecture on November 21 at the Central Hall, London, it has been found necessary to arrange two meetings—for the afternoon at 3 P.M. and the evening at 8.30 P.M.

A PRIZE of 1000 guineas has been offered by Messrs. Selfridge and Co., through the Royal Aero Club, for the first flight of fifty miles made by a British pilot on a British-built glider, the distance to be measured in a straight line from a given point of departure. The prize will remain open for a year from January 1, and if it is not awarded, a prize of five hundred guineas will be given for the longest flight of more than twenty-five miles during the year.

IT is announced in *Science* that the Howard N. Potts Medal of the Franklin Institute has been awarded to Dr. Charles Raymond Downs and Mr. John Morris Weiss of New York "in consideration of their notable achievement in the scientific and commercial development of the catalytic vapour-phase oxidation of benzene to maleic acid and their pioneer work in developing a commercial process for changing aromatic to aliphatic compounds."

WE have referred in these columns from time to time to the preparations which are being made in France to celebrate the approaching centenary of the birth of Pasteur. British men of science have had an opportunity of sharing in the celebrations and we now learn from *Science* that the New York Academy of Medicine is organising an exhibition in commemoration of the event. The exhibition, which will be opened on December 27, will consist of a collection of books, manuscripts, photographs, engravings, etc., illustrating the life and work of Pasteur, and will conclude with a number of addresses by distinguished members of the medical profession.

A NEW Danish expedition to the Sahara is announced in the *Times*. Under the leadership of Prof. Olufsen, the expedition will shortly leave Tunis for the Shat-el-Jerid. From Nefta it will go by Tuggurt to Wargla in the Algerian Sahara, and thence to Insalah, and endeavour to explore the Hoggar Mountains. The members of the expedition will include Dr. Gram, botanist, Drs. Storgaard and Kayser, geologists, and Prof. Bourcart, of the Sorbonne. Dr. Olufsen expects that the journey will occupy some six months.

NEWS from Mr. K. Rasmussen brings the story of his researches in Baffin Land and the Hudson Bay region down to the end of July. According to the *Times* the winter work was carried out according to programme. Surveys were made of the north coast of Fury and Hecla Straits, and that part of Baffin Land between Gifford Bay and Admiralty Inlet. Mr. Rasmussen himself was chiefly engaged in his

researches on the migration routes of the Eskimo, and in order to become acquainted with the local dialect stayed several months in a small Igdlulik settlement at Cape Elisabeth. At the end of March Mr. Rasmussen, with two companions, left for Chesterfield Inlet on his way to the Aivilik and Netjilik tribes. Baker Lake was reached early in May and Yathkied Lake in June. From there the party returned in July to Chesterfield Inlet. The country between Chesterfield Inlet and Yathkied Lake is inhabited mainly by pronounced inland tribes of Eskimo who only during recent decades have begun migration to the sea coast. They live on bad terms with the nearest Indian tribes, and some of them had never seen white men. Their legends often agree in minute detail with the Greenland legends: their religion is on a much lower level. Mr. Rasmussen considers these tribes to be the most primitive that he has ever met: this is also shown in weapons, houses, and boats. Everything connected with the sea is taboo. The stone houses are unheated, as no blubber is available. Salmon fishing and reindeer hunting are the only means of livelihood, and starvation is not an uncommon experience of these tribes. Steensby's theory that the Eskimo were originally inland American people receives support from these discoveries. The inland tribes which Mr. Rasmussen studied very likely may be the last survivals of the primeval Eskimo who have not yet reached the sea.

PROF. LEONARD HILL delivered a Chadwick Public Lecture on "Ventilation and Atmosphere in Factories and Workshops" on October 26. Prof. Hill emphasised the fact that it is not the relative humidity that matters, but the actual vapour pressure of the air coming in contact with the skin; the breathing of cool air entails more evaporation from the respiratory membrane and consequent greater outflow of lymph through the secretion of fluid from it. Thus the membrane is better washed and kept clean from infecting microbes. The open-air worker is thus better protected, and moreover escapes the massive infection from carriers which occurs in shut-up rooms. Wet-bulb temperatures in factories and mines are physiologically more important than dry-bulb temperatures; the velocity of the air is an important consideration, for on this chiefly depends cooling by convection and evaporation. The cooling and evaporating powers of an atmosphere can be measured by the kata-thermometer, a large-bulbed spirit thermometer. Furnace- and engine-rooms should be ventilated by fans at the bottom of wide trunks down which cool air naturally sinks, the fan breaking up the air into fine streams. Rooms are best ventilated by open windows or a system of fans to impel cool fresh air through gratings about eight feet from the ground and extract it through apertures in the ceiling; floors and walls should be warmed by radiant heat from gas or coke fires.

THE Eastman Kodak Company of New York has issued the fourth volume of "Abridged Scientific Publications from the Research Laboratory of the Eastman Kodak Company," a volume of about 340 pages. It includes abridgments of 54 papers that have been published during the years 1919 and 1920 in various scientific journals and the proceedings of scientific societies. The abridgments are not mere expansions of the titles, as is too often the case just now, but useful and often long abridgments giving details of methods and results. At the end of the volume there is a complete list of all communications issued by the Laboratory (a total of 117), and indexes of authors and subjects for the four volumes. The subjects dealt with cover a very wide range. Besides those that are obviously related to photography, which are divided into nine sections, there are papers on photometry, colour measurement, sensitometry, photographic optics, physiological optics, chemistry, physical chemistry, electro-chemistry, colloids, and radiography. The volume is undeniable evidence of the activity of those who work in this Laboratory and of the broad views taken of the subject by the Director.

WITH reference to Dr. Hale Carpenter's letter describing a waterspout published in our issue of September 23, p. 414, we have received a letter from Mr. E. R. Welsh, Devon, Pa., U.S.A., in which he suggests that in a waterspout, centrifugal force would cause a partial separation of air and waterdrops, the waterdrops tending to concentrate in an outer sheath, while within the sheath there would be a region with lower waterdrop content; the continued existence of the central core would be provided by the uprush of spray from the surface of the water. Mr. Welsh suggests that the appearance of pulsation in the outer sheath might be explained by the rotation, combined with a spiral fluting of the sheath.

IN his presidential address before the Institution of Automobile Engineers, Colonel D. J. Smith warned the members that they must not allow themselves to be engrossed entirely in the technical aspect of the motor car; there are many other questions which might have a great effect on the well-being of the industry. He urged upon automobile engineers the necessity of not being content to design a car which would run on the comparatively good roads in this country. The local conditions in the various parts of the British Empire should be ascertained and steps taken to design cars to meet these conditions. The most suitable vehicle for any market captures that market, price being a secondary consideration. Col. Smith believes that the chief development in Great Britain would lie in the direction of vehicles carrying fourteen to sixteen people and luggage, which could compete with the railways in providing rapid and frequent passenger service, and so opening up rural districts in a manner not hitherto contemplated. He also criticised strongly the present methods of road construction, and likened the result to that which would prevail if the track of the L. & N.W. Railway were maintained by the different borough councils of the areas through which the track passes between London and Scotland, each employing its own unemployed and using local unsuitable material. In connexion with the carrying capacity

of roads, the reduction due to tramway services was mentioned—a five minutes' service reduces the carrying capacity by 50 per cent., and a two minutes' service by 80 per cent. The country cannot afford tramways, and their comparatively early disappearance is certain. In reference to standardisation, Col. Smith urged that standards once decided upon should be used, and condemned the conception that a design would lose individuality by the adoption of standardised parts. Again, automobile engineers should not consider liquid fuel as the only fuel available. In many countries charcoal is available at prices which make it equivalent to petrol at a few pence per gallon. There is a need for a steam vehicle suitable for such fuel, and of a lighter type than those generally seen.

THE *Journal of Pomology* is to be made, in effect, the official organ of the horticultural research stations in England, and with this change the name of the journal will become the *Journal of Pomology and Horticultural Science*. Its scope will be widened and it will be under the control of a publication committee consisting of Prof. B. T. P. Barker, Horticultural Research Station, Long Ashton, Bristol; Prof. R. H. Biffen, Horticultural Research Station, Cambridge; Mr. E. A. Bunyard, Maidstone (Editor); Mr. H. E. Dale, Ministry of Agriculture; Mr. R. G. Hatton, Horticultural Research Station, East Malling, Kent; and Mr. H. V. Taylor, Ministry of Agriculture. The research stations at East Malling, Long Ashton, and Cambridge have assumed financial responsibility, It is anticipated that four numbers of the journal will be issued annually, the first of which will be ready this month.

A VERY comprehensive catalogue of works dealing with chemistry in all its branches has just been published by Messrs. Wheldon and Wesley, Ltd., 2 Arthur Street, New Oxford Street, W.C.2. Nearly 3000 publications (many of them rare) are listed under some 44 headings. Being carefully classified according to subjects the list should certainly be seen by readers of NATURE interested in chemistry.

Our Astronomical Column.

LARGE METEOR OF OCTOBER 17.—Mr. W. F. Denning writes: "This remarkable meteor was observed at Bristol, and also by Mr. W. Tidmarsh at Exeter at 11.46 P.M. on October 17. The radiant point was at 152° +39°. The luminous flight of the object was unusually long, and extended from over Stafford to a point in the English Channel about 30 miles south of Plymouth. The radiant point being near the horizon, the course through the atmosphere was almost parallel with the earth's surface. Its height declined from 71 to 62 miles, the path being about 225 miles long and the velocity 37 miles per second.

"This meteor was very similar in many respects to brilliant meteors which appeared on October 15, 1902, and October 22, 1919. Their radiant points were at 150° +43° and 156° +39° respectively. The comet of 1739 has a radiant point at 157° +39° on October 22, and may well have supplied the three bright meteors referred to above."

VARIABLE STARS.—Owing to the completeness of the data of variable stars of long period which are being sent in to Mr. Leon Campbell by his host of energetic observers, the Harvard College Observatory Bulletin, No. 776, announces that it is possible to estimate the approximate magnitudes of most of these stars for any given date several weeks ahead. It is therefore proposed to make the predictions one month in advance and to publish them bi-monthly. This arrangement is very satisfactory, because those who do not possess large instruments will be able to observe some stars when they are brighter than a certain magnitude, and will know when to commence the observations. Again, many of these stars are most interesting spectroscopically, and they can be followed when it is known that they are bright enough for the particular instrument the observer possesses. In this publication the variables are published in groups according as they become brighter than a certain magnitude after a certain date. Thus the date chosen here is November 1, 1922, and the variables are grouped as follows: those that will be brighter than magnitude 8·0; those that will be between 8·0 and 10·0; 10 and 12; 12 and 14; and fainter than magnitude 14.

THE DISTANCE OF THE CEPHEID VARIABLES.—Prof. Kapteyn and Mr. van Rhijn examined the proper motions of the galactic Cepheids of short period, and concluded that their distances were only about one-seventh of those given by the formula of Prof. Harlow Shapley, employed in Prof. Shapley's researches on the distances of the Globular Clusters. He replies to their paper in Circular 237 of Harvard College Observatory, giving reason to believe that the stars in question have unusually high linear velocity, which would affect the parallax derived from the proper motions. He shows that their apparent drift is not directed away from the solar apex, indicating that they have independent velocity. In several cases the spectroscope has confirmed this, the velocities 50, 51, 193, 74, 49 km./sec. being found in five cases. Shapley then quotes the recent work at the Sproul Observatory, where the parallaxes of the Cepheids have been trigonometrically examined, the results confirming the spectroscopic parallaxes. These stars are concluded to belong to the stream of high-velocity stars, found by Adams, Joy, and Strömberg at Mt. Wilson to have a space velocity of some 200 km./sec. Since this is comparable with the average line-of-sight velocity of globular clusters, it is conjectured that the galactic Cepheids may originally have been members of the same cluster, and be merely travellers passing through the solar cluster.

The spectroscopic parallaxes agree closely, star-for-star, with those based on the period-luminosity curve, which strengthens the case for the adoption of the latter.

NOVA SCORPII 1922.—This object was discovered at Arequipa by Miss Cannon. On July 1 it was invisible and less than magnitude 12·5. On July 11, 12, and 17 its magnitude was 10·5, 10·0, and 9·9 respectively, the latter being the maximum; on August 2 it had fallen to 10·2, and on August 21 (Harvard) to 11·4. The spectrum is of the Nova type; bright bands were probably absent on July 12, but certainly present on July 25. Search on plates made in former years shows no star as bright as magnitude 15 in the position.

Research Items.

THE CREEK INDIANS.—Mr. I. R. Swanton, in Bulletin 73 of the Bureau of American Ethnology, has followed up his study of the Indian Tribes of the Lower Mississippi valley (Bulletin 43) by an account of the Indians of the Creek Confederacy, about 9000 of whom were enumerated in 1910. This report does not deal with field work among the tribe, which is reserved for later publication, but is an attempt to gather from documentary sources an account of their movements from the earliest times until they are caught up into the stream of later history, in which concealment is practically impossible. It justifies the author's claim that it is an encyclopædia of information regarding the early history of the south-eastern Indians. A full bibliography and good maps will do much to assist the student of the ethnology of the American Indians.

THE STUDY OF FINGER-PRINTS: IDENTIFICATION OF COWS.—In the fourth number of *Dactylography*, a journal devoted to the study of finger-prints, Mr. C. L. Enos, superintendent of the State Bureau of Criminal Identification, Colorado, states as the result of his experiments that, as the human being can be identified by his finger-prints, it is reasonably certain that the pattern or design which Nature has provided at the end of every cow's nose may be made to serve the same purpose. Up to the present no precise classification has been worked out, and this will be necessary before such prints can serve a practical purpose. The noses of several calves have been printed each month for one year, and if further experiments show that these patterns persist during the life of the animal, it will supply a practical means of identification which will be valuable to all breeders and to the police.

THE MUSIC OF THE UTE INDIANS.—Miss Frances Densmore, well known by her previous studies of the music of the Chippewa and Teton Sioux tribes, contributes an account of that of the Ute tribe in Bulletin 75 of the publications of the Bureau of American Ethnology. This tribe, the origin of whose name is disputed, formerly occupied the entire central and western parts of Colorado and the eastern part of Utah, including the eastern part of Salt Lake valley and the Utah valley. The present work concerns only the Northern Utes, living in reservations in north-eastern Utah. They used to live in *tipis* covered with elk hides, but now log huts are extensively used in winter. They have never been a warlike tribe, but their tenacity of opinion has repeatedly brought them into contact with the Government; their characteristic is quick transition of mood concerning matters of secondary importance. The author gives a good account of their musical instruments, and has collected a number of songs—those of the Bear dance, Sun dance, Turkey dance, war songs, those used in the treatment of the sick and in connexion with games—which will interest both the student of music in the lower culture and the anthropologist.

JAPANESE PLIOCENE FOSSILS.—Some time ago we directed attention to a memoir by Prof. M. Yokoyama on fossils from the Lower Musashino Beds (Red Crag age) from the Miura Peninsula, Japan (NATURE, August 26, 1920, p. 836). To the same author we are now indebted for another valuable memoir (Journ. Coll. Sci. Tokyo, vol. 44, art. 1), this time on the Mollusca and Brachiopoda of the Upper Musashino Beds of Kazusa and Shimosa, to the east of Tokyo, that he considers to be of Upper Pliocene or even newer age, since the shell layer is near the top of the formation. There are 335 species described and a careful table of their distribution given, with notes as to their occurrence elsewhere, living or fossil. From this it is seen that six species are also found in our English Crags, one in the Pliocene of Italy, and several in North American Upper Tertiaries and Post-tertiaries. No less than 103 species are said not to be known living, while some 113 species are described as new, and, with many others, figured excellently on the seventeen appended plates. As in the case of the previous monograph, the nomenclature will not always pass muster with adherents to the international rules for zoological nomenclature.

FOSSIL VERTEBRATES IN CENTRAL ASIA.—More than twenty years ago a Russian geologist, W. Obrutschev, observed an extensive freshwater formation between Urga and Kalgan in Mongolia. He obtained from it the remains of a rhinoceros of middle or late Tertiary age. In the early part of this year, Messrs. R. C. Andrews and W. Granger, of the American Museum of Natural History, through the generosity of several friends of the Museum, were able to visit the same region and explore the formation more thoroughly. A preliminary report of their results is published by Prof. H. F. Osborn in the September number of *Asia*, the American magazine on the Orient. It now appears that the freshwater deposits represent a long period, and contain numerous fossil bones. The lowest horizon, apparently of Upper Cretaceous age, yields remains of dinosaurs closely related to those of the same age found in North America. They include iguanodonts, megalosaurians, and small running dinosaurs allied to Ornithomimus. Crocodiles and turtles are associated with them. The next horizon is evidently of Eocene age, and contains remains of hoofed mammals, some being small lophiodonts and others much resembling the peculiar titanotheres which are found in the Eocene of North America. In a still higher horizon there are large land tortoises, carnivorous mammals, and rhinoceroses, besides a gigantic rhinoceros-like mammal which may be related to the Baluchitherium discovered by Mr. Forster Cooper in Baluchistan. The collection which has been made will add greatly to our knowledge both of reptiles and mammals and of their geographical distribution. Geologists and palæontologists will await the detailed descriptions with interest.

ECOLOGY OF "FLOATING ISLANDS."—"Floating Islands," on which little colonies of vegetation maintain an independent, if precarious, existence, cut off from all connexion with the mainland, early attracted the attention of travellers, and have been reported from lakes, rivers, and the open sea. One of the earliest references is made by Herodotus to the floating islands of the Nile, and an interesting Japanese study by Harufusa Nakano (Journ. Coll. Sci. Tokyo, vol. 42, art. 3) quotes early Japanese and Chinese references, the earliest Chinese citation dating from about A.D. 300. Nakano shows that these floating islands may be found on inland waters in both the Northern and Southern islands of Japan. He traces their origin to various causes. Sometimes pieces are isolated from an indented coast-line by various factors active in erosion, as ice formation or frequent changes of water level; these pieces ultimately break adrift and float away. In other cases plant communities build themselves up from the shallow lake bottom and appear above water away from the land, ultimately losing their root anchorage and floating free; such

islands are usually almost pure colonies of one species, as the islands of *Typha japonica* or *Zizania aquatica*. Another type of island consists mainly of one species of a free-floating plant, such as the islands of *Eichhornia crassipes*. A very interesting case is reported by Nakano from the shallow lakes found in high moorland regions. Here masses of peat, crowned with vegetation, may be raised from the bottom of the lake in large part by the gaseous products accumulated from decomposition processes, in part by the buoyancy of the tissues of the living plants; such islands may be recurrent, sinking and rising in different seasons. Floating islands are gradually leached of any humus or mineral nutriment they may originally possess, so that their base is ultimately mainly a tangle of roots and fibre. It is to this cause that Nakano traces the gradual disappearance of some of the colonists prominent on the newly formed islands, such as *Phragmites longivalvis*, not as Pallis has suggested for the "Plav" on the waters of the Danube (Journal of the Linnean Soc., vol 43, 1916) to the degeneration of a vegetatively propagated plant.

NEW MAPS OF THE GOLD COAST.—The Survey Department of the Gold Coast, which was closed during the war, was reopened in 1920 under Lieut.-Col. R. H. Rowe. Work has been pushed forward so rapidly that about 15,000 sq. miles have now been surveyed and the publication of the maps has begun. The sheets, which are printed by Messrs. W. and A. K. Johnston, are on a scale of 1 : 125,000. Relief is shown by brown form lines at an interval of 50 feet. Water features and names are in blue. Green is used for forests, and various symbols are employed to show the different kinds of plantations. Seven classes of roads and tracks are shown. Soundings in coastal waters are given in fathoms. The Accra sheet which has just been published is an excellent piece of work, and is notable both for its clarity and amount of detail. The same publishers have also produced a folding-map (scale 1 : 1,000,000) of the Gold Coast, Ashanti, Northern Territories, and British Togoland. No relief is shown. Colour is used for provincial and other boundaries, water features, and motor roads. This is a less striking map, but should prove useful for general reference purposes.

TROPICAL CYCLONES IN SOUTHERN HEMISPHERE.—A summary of tropical cyclones in the South Pacific, Australia, and the South Indian Ocean, by Dr. S. S. Visher, is given in the *U.S. Monthly Weather Review* for June. For the South Pacific 246 hurricanes are discussed. The huricane season extends from December to April, and during this period about 95 per cent. of the recorded storms have occurred; January alone has 30 per cent., while the six months from May to October make up only 4 per cent. of the total. A table gives the frequency of occurrence in the several island groups. A second table shows the number of hurricanes between the longitudes 160° E. and 140° W. for the several months and years, consecutively for the years 1830 to 1922. There is a further table which gives approximately the region of the origin of cyclones in the South Pacific, which shows a prevailing majority between 15° and 20° south latitude. Similar tables are given for recorded hurricanes, between 100° and 160° E., for Australia and adjacent waters. The maximum number of the approximate origins or places of first record occurs between 10° and 15° S. The main season for the Australian hurricanes is from December to April, and during this period about five-sixths of the storms occur. Storms are rare from May to November. Of the tropical storms in the South Indian Ocean, both January and February have 25 per cent. each and March 20 per cent. of the total. Storms are extremely rare from June to September. On the average rather more than a dozen tropical cyclones occur annually in longitudes 40° to 100° E. There is generally a preponderance of storms during recent years in the three regions, doubtless due to an increased number of observations. Representative tracks are well illustrated on two charts. The author states that many widely accepted generalisations as to tropical cyclones appear unsafe in the light of fuller data being gathered.

TREATMENT OF TIN AND TUNGSTEN ORES.—The Tin and Tungsten Research Board, under the chairmanship of Sir T. Kirke Rose, has recently given an account of the work done during the period January 1918 to December 1920, when its activities came to an end (Department of Scientific and Industrial Research. Report of the Tin and Tungsten Research Board. Pp. vi + 100. London: H.M. Stationery Office, 1922. 3*s*. 6*d*. net.). As a useful introduction to the papers dealing with the various investigations that have been carried out, an account is given by F. H. Michell of the methods already in use for dressing tin ore in Cornwall, and E. H. Davison gives a report on the microscopic examination of veinstones. The ore-dressing investigations include work on flocculation-effects and friability tests by S. J. Truscott and A. Yates, and an investigation by H. S. Hatfield of various physical properties in relation to concentration possibilities. Hatfield found that the osmose process was inapplicable to the separation of cassiterite. He also found that there is little prospect of increasing the yield on the dressing floors by the addition of flocculating agents to the pulp. His work on dielectric constants as a basis of separation is novel and interesting, depending as it does on a property which, like magnetic permeability, is characteristic of the whole mass of a mineral particle and not merely its surface, and is applicable to minerals generally. Other researches, by Sir T. Kirke Rose, J. H. Goodchild, and others, deal with chemical and metallurgical methods, including the use of solvents to remove cassiterite or wolfram by direct solution, the conversion of cassiterite or wolfram by furnace methods into a soluble product, followed by leaching, and the removal of the tin or wolfram from ores by volatilisation, followed by condensation. The report thus deals with many aspects of ore-treatment. It gives a large amount of information which will doubtless receive due attention by those interested in the Cornish tin-mining industry, and will presumably be put to the test so far as is practicable when the mines re-open.

SEPARATION OF ISOTOPES OF CHLORINE.—In the Memoirs of the College of Science of Kyoto Imperial University, vol. iv., No. 7 (March 1921), Dr. Ishino describes experiments with the crossed deflection positive ray method, in which a separation of chlorine into isotopes was obtained. The paper was received on July 22, 1920, and the work was completed in September 1919. Dr. Ishino made experiments to see if the separation of the parabolas (which are clearly shown in the plates) was due to impurities, and was able to show that this was not the case. He found the atomic weights of the two isotopes to be 34 and 36; a line, 37, was due to hydrochloric acid; the other hydride (35) had no corresponding line, but the broadening of the line 37 seems to show the existence of such a hydride. The connexion with the "whole number rule" and the helium nucleus is pointed out.

The Peril of Milk.

By Prof. HENRY E. ARMSTRONG.

A CONFERENCE of a most important and serious character was held in the Council Chamber of the Guildhall, London, on October 16-18, during the week of the Dairy Show, dealing with our milk supply in practically all its aspects—except the scientific! Yet we speak of science as salvation, perpetually proclaim its importance, and deplore public apathy towards its priesthood. Our class was not invited to participate. I heard of the conference only casually and bought myself in, only at the very last moment; consequently I was relegated to a place in the gallery behind the speaker's chair, where I could not hear a word. Being unobtrusive in my ways, I descended to the floor and trespassed into a vacant seat; the platform was all but empty but no invitation to take a chair upon it came down to me. I do not wish to complain but merely point out the rewards of scientific service and the effusive way in which the man of affairs welcomes our aid.

I make this statement, indeed, just to show where we are in public esteem, when subjects of vital importance to the national welfare, with which we alone can deal effectively, are under discussion—nowhere! Whose is the fault? Our own! We are mouldering away in our laboratories and when we seek to make known what we have been doing use a jargon which we cannot ourselves understand. That we have a public duty to perform seems never to occur to us. Much of our so-called research work is very largely wasted effort, without any real intelligence behind it —without policy and without imagination. The real problems are all but untouched.

Our knowledge of milk is practically nil—this was made clear at the conference. As the result of our careless abstention from the affairs of the world, sentiment and commercialism are quietly, without hindrance, wreaking their will upon the country. Few are aware, I think, of the extent to which milk is ceasing to be milk as the cow gives it: how it is being tampered with to overcome initial avoidable carelessness, to make it keep and to satisfy the undiscriminating animus against micro-organisms engineered into existence, of late years, by bacteriologists. Apart from the wonderful livestock, *the* feature of the Dairy Show was *Pasteurising* plant. One of the most interesting of these is to be operated at 135° C.!

I was the first to take the floor after the opening paper was read, dealing with breed of cattle in relation to quantity, composition and cost of milk production. I deplored the absence of the chemist and insisted that we know nothing of the composition of milk in any proper sense of the term—that to talk of it in terms of fat and solids-not-fat was equivalent to describing a house in terms of percentages of bricks, mortar, wood, etc. Modern discovery had taught us that the essential value of milk lay in certain mysterious minor constituents which could neither be identified nor quantified—yet were of most vital consequence: which I would term *advitants*—to catch the public ear, maybe *vitalites* were better—but refuse to misname vitamins.

To justify Pasteurisation, we have to show that no harm is done to milk by heating it above bloodheat. To heat it above this temperature is to treat it *unnaturally*—this cannot be gainsaid. That it is altered thereby is proved up to the hilt. The contention is that, by making a certain addition, we can compensate for the alteration—but we have only superficial evidence in favour of this contention. The medical profession has only recently had its attention directed to these matters—it does not know yet what to look for. The effects may be deep-seated, we know; and they may come but slowly under notice. Time alone, combined with the most refined study of the problem, can prove that it is safe to trespass beyond Nature's limit. The second teeth, we know, are formed at birth; scurvy affects their structure ere change be noticeable externally; and so it may be in other cases. The bad teeth of our nation are probably, at least in large part, due to defective nutrition in early years and they affect us throughout life. Nations whose children are all breast-fed have good teeth.

The only rational assumption to make is that no constituent of milk is without a purpose and that, if anything in it be destroyed, it loses in dietetic value. The recent remarkable discovery, that a something secreted by the pancreas, no gross constituent apparently, is required for the normal metabolism of so combustible an article of diet as sugar, should be a warning against destroying any natural agent in a whole food like milk; especially in view of recent work by Gowland Hopkins.

At a time when we are beginning to know these things, we have no right to develop an unnatural practice and allow it to become general. We must gain much more knowledge before making up our minds. On all sides, at the conference, it was recognised that clean raw milk can be produced and purveyed, if we will but take a little care.

Scurvy, rickets, beriberi, we know, are diseases affecting us as consequences of malnutrition; scurvy became rife in Denmark early in the war, on the farms, when the children were fed on Pasteurised milk. Who shall say that a host of our minor complaints are not due to dietetic deficiencies? Women are often most faddy feeders and the frequent appearance of nervous disorders in their sex may well be connected with lack of vital elements, even due to seed sown in infancy. We may be laying the foundation of complaints worse than cancer.

Who knows or does not know? At present we can *assert* nothing, either way, so crass is our ignorance: so let us halt while we may.

The effect of food on the cow's milk was more than once brought out at the meetings. We were told that milk from cows that had been stall-fed but grazed occasionally proved vastly richer in one of the advitants than that from animals simply stall-fed; also that two varieties of one root crop had different effects on the production of milk. Pigs apparently give healthy pork when grass-fed but not when starved of green food. The whole field of food inquiry lies open before us. Prof. Stenhouse Williams—dairy bacteriologist at Reading College—and I were the only speakers to sound the note of nutritional danger from Pasteurisation. We stood alone. Rothamsted, which claims to stand at the head of agricultural research, was unheard; the Animal Nutrition station at Cambridge was voiceless. Sir W. Morley Fletcher, of the Medical Research Council, who took the chair at the discussion on Pasteurisation, had not a word to say by way of caution. The Medical Research Council, however, has never had a chemist among its members; and yet medicine is nothing but applied chemistry.

Where, we may ask, are the Prophets? Science is simply disgracing itself in this matter of milk: the call to wake up and defend the public health must go out everywhere.

Indian Institute of Science, Bangalore.

ALTHOUGH only 203 students have worked for various periods in the laboratories of the Indian Institute of Science at Bangalore since its opening in 1911, and although only 14 of these have been regarded by the council as suitable for the diploma of associateship, the history of the Institute is of special interest to students of educational methods. The conditions affecting the activities of the Institute depart, however, so widely from the normal that it is impossible at this stage in its history to be sure whether any, and what, changes in the administration of the Institute would have resulted in more visible success. Bangalore, the site selected for the Institute by the late Sir William Ramsay, is mainly a military cantonment. Its position as a centre, either of scientific education or of technical industries, is almost negligible. The Institute itself occupies isolated ground far enough from the town to cut it off largely even from the limited social amenities obtainable in an Indian cantonment station. Distances in India are of the continental order, and university graduates, being generally married in early life, hesitate naturally to leave the established university cities to undertake post-graduate training at a distant institute which has no traditions, no connexions, and no established market value. Moreover, the number of science graduates qualified in India to undertake research work has hitherto been very small.

The machinery of government originally designed for the Institute reproduced some of the ordinary features of established universities, including a large "court," composed of widely dispersed members who have never even met as a body. Even the relatively small council is handicapped by the distance of some of its members, and its meetings have thus been largely controlled by the resident professorial members. Influenced by desire for a special review of progress by an entirely independent expert body, the standing Committee of the Court in 1921 requested the Governor-General in Council to appoint a committee of inquiry, which met towards the end of the year under the chairmanship of Sir William Pope, professor of chemistry at Cambridge; and the report of the committee recently made available forms a valuable study of this artificially created institution.

Hitherto the work of the Institute has been limited to two groups, which are distinct from one another in nature and method of training. In the department of pure and applied chemistry, students have been engaged in research problems; there has been, however, no systematic course of training, either by lectures or laboratory work. In the department of electrical technology, on the other hand, students have undergone a more systematic training, with the view of qualifying as practical electrical engineers. There has been no department of physics to link the other two, and no department of mechanical engineering on which to base the training in electrical technology.

Up to 1918 the annual income of the Institute amounted to something less than 17,000*l.*, but recently, owing to the sale on advantageous terms of the investments left by the founder, the late Mr. J. N. Tata, the income now available is nearly doubled.

The committee, in accepting the conclusion that the Institute has not fulfilled the just expectations of its founder, wisely refuses to discuss the merits of the specific complaints made against its administration, and limits its report to the discussion of proposals for reform. In the first place, the committee, after briefly reviewing the standard of scientific training obtainable at Indian institutions of university rank, considers it desirable to establish, by lectures and laboratory practice in the Institute itself, definite courses of instruction which will lead the ordinary science graduate from the stage at which he usually leaves the average university college to that which will qualify him for systematic research.

Having given an outline of the fundamental policy to be kept in view, the committee proceeds to discuss plans for the logical expansion of the departments already established, assuming this to be preferable to the immediate introduction of additional branches of science. The scheme outlined contemplates the institution of eight professorships in branches of pure and applied chemistry, and these are to be linked with the now isolated department of electrical technology by a chair in general physics. It is proposed also to establish two additional chairs, namely, one in applied mechanics and another in thermodynamics, for the purpose of rendering more effective the training in the department of electrical technology. For the time being this scheme goes as far as it is safe to project future developments; even this will require a larger income than is now in sight. Indeed, two new chairs will practically absorb the present annual surplus, and the committee thus recommends that the first two chairs established to supplement existing activities should be preferably in chemistry and in thermodynamics and heat engines.

To create in other parts of India an extended interest in the Institute, the committee recommends a reconstitution of its government machinery. To the court it is proposed to add representatives of any new benefactors that may appear, as well as representatives of all the "reformed" Governor provinces, except Assam.[1] The committee proposes also to introduce a representative of each of the new legislative councils, Assam not in this respect being specifically excepted. These changes, the committee hopes, will create a friendly interest in the Institute in other parts of India; but the tendency (always manifest, and now decidedly strengthened by the recently reformed constitution) of developing provincial institutions may neutralise to some extent the committee's expectations in this respect. The only alternative plan of dispensing with such large controlling bodies introduces, however, dangers of the kind that, according to some witnesses, have adversely affected the development of the Institute hitherto.

The council now proposed as the body responsible for the determination of matters of policy, for finance, and for the appointment of a staff, includes the executive head of the Institute, who is styled principal in preference to director, together with eleven other members, composed of five nominees of the Indian universities, two of the Tata family, two of the Mysore State, one of the Indian Legislative Assembly, and a scientific officer to represent the Government of India. An explanatory paragraph in the report assumes that by this scheme the central government will be represented by two nominees, but the nominee of the Indian Legislative Assembly would be in no sense a representative of the Government of India.

For purely academic business it is proposed to establish a board of studies, composed of the principal, the professors, and certain other members of the staff.

The committee recommends that the principal should be a scientific man of eminence, with proved administrative capacity. This obviously wise prescription has been observed in the recent appointment

[1] We understand that the Government of India proposes to add to the government machinery of the Institute a representative of Assam and another of the newly constituted University of Delhi.

of Dr. M. O. Forster, although apparently it has not been found possible to combine these two qualities with "considerable Indian experience," which the committee regards as "almost essential."

Among the many difficult questions which the committee has carefully considered are: (1) The claims of local administrations on the services of the professorial staff for special investigations outside the Institute. Admitting the occurrence of exceptionally urgent instances, the committee thinks that any tendency in this direction to take members of the staff away from their immediate duties inside the Institute should be resisted. (2) The investigation of special technical problems for outside persons. These, the committee thinks, might be permitted under suitable control at the expense of the applicants, so long as a fee be also charged and be wholly credited to the Institute funds, no part of the fees thus obtained being granted to the salaried members of the staff who may undertake the work. (3) The committee considers that the higher staff should not accept any private practice which involves work to be carried out in the Institute laboratories, although it might be permissible for a professor to undertake purely consulting practice, subject to the approval of the council and with specified limitations. (4) While a member of the staff should enjoy the copyright benefits of any book of which he is the author, the committee is less decided about his taking out patent rights for inventions arising out of work done at the Institute. Each specific case of the sort which arises should be dealt with by the council on its merits. (5) Technical investigations in the Institute which successfully lead to work on a factory scale (when, naturally, commercial interests intervene) should be stopped at this stage. In the opinion of the committee, the work should then be transferred to a commercial firm, which might, if necessary, employ members of the staff in a purely consultative capacity. (6) The Institute should not undertake routine analyses and determinations; these should be left to the private enterprise of outside chemical firms.

The committee thinks that the necessary co-ordination of the work of the Institute with that of Indian universities will be in part effected by the university representatives on the council and by more efficient publication of information regarding the activities of the Institute itself. It is suggested that the Journal of the Institute should be expanded to be made of more general interest; that the local organisation of an Indian section of the Society of Chemical Industry should be undertaken; that the staff should be encouraged, by the grant of travelling expenses, to take part in the annual meetings of the Indian Science Congress; and that a report on the research programmes in progress at the Institute should be submitted annually to the Indian Board of Scientific Advice.

Because of the isolated location of the Institute, the committee recommends an improvement in the hostel accommodation, especially for the benefit of married students, and generally an increase in the facilities for games and other social amenities. To ensure that progress is effected on sound lines, it is recommended that the Governor-General in Council as visitor should institute, once in every quinquennium, a review of the operations of the Institute by a special committee of inquiry.

Psycho-Analysis and Education.

THE place of psycho-analysis in schools was the subject of a discussion at a joint meeting of Sections of Psychology and Education of the British Association meeting in Hull. The crowded meeting testified to the evident interest taken in the subject, and to the growing appreciation of the need in educational work of a closer co-operation between those who are responsible for the training of the young, and those who are making a scientific study of mind working and development.

It will be well at the outset to state that the term psycho-analysis was used by all speakers in the broad sense of mental exploration to discover, or at least trace, the mental history of the abnormal child, the cause of his mal-development, feeble intelligence, delinquency, or vicious conduct. In no case was the term used in the strict Freudian sense; in fact, Dr. Crichton Miller, one of the speakers, expressly stated that, in order to avoid any misconception arising from the use of a term that might imply exclusively the theory and technique laid down by Prof. Freud, he preferred to use the term analytical psychology.

Appearing first as a method of treating nervous disorders Dr. Miller said that analytical psychology has a wider function. Its real scope and value should be preventive, its application as universal as the accepted principles of hygiene, and its propaganda carried on by all who have a stake in the next generation. Hence its importance to teachers, and hence the necessity for teachers to understand and value it in their own experience.

The advent of analytical psychology marks a new era in education because it makes a new demand, that the teacher should know, not only his subject and his pupil, but himself. It follows that one of the chief functions of analytical psychology in education is not to enable the teacher to analyse his pupils—a technical task for which he cannot usually have either the time or the training—but to help the teacher to recognise and remedy failures of character development in himself, the inherent childishness, the prejudice, and self-deception which are the chief obstacles to understanding children, and handling them wisely. If there are still teachers who maintain that analytical psychology is irrelevant to their work, Dr. Miller reminded them that their failures will come to be judged by analysts later who have to attempt the re-education of the adult who might have developed into a man, and instead developed into a neurotic.

Dr. C. W. Kimmins in opening the discussion presented the case from the schools point of view, and claimed that the time was singularly opportune for a clear statement by the experts of the possibilities, and limitations, of the part a well-qualified psychologist could take in the appraisement of intellectual values, and in helping to solve those complex problems presented by the abnormal child.

The improvement attending the use of intelligence tests in the selection of children for promotion over the method of marks gained by the usual examination method has already been demonstrated, and there is no doubt that in the greater freedom of the child, and the fuller scope it has of self-expression and self-development under the Montessori system, the Dalton plan, or any other similar form of school organisation, many of the so-called psycho-pathological cases would disappear. But the child that will not respond to normal methods of instruction or treatment will probably always exist. The boy who has no apparent mental or physical defect, is interested in out-of-door life and plays games but shows no interest in instruction, and is always at the bottom of the class, is an educational failure, and a case for the psychologist. A day-dreamer is another type.

These Dr. Kimmins would have treated at psychological clinics such as are already established in the United States, America, and other countries, in which very useful results have been obtained. He also suggested that if the teacher had a fairly sound knowledge of his own personal equation it would greatly increase his efficiency.

Dr. Hamilton Pearson claimed that the practical application of psycho-analysis had a place in school routine with two reservations, namely, that the operator should be not only a trained analyst, but should have special experience in child analysis, since the technique is different, and the work altogether more difficult and delicate than with adults; and secondly, that the limitations of the field of application within the radius of our present knowledge are thoroughly understood. In helping to define those limitations it may be taken as a rule that no child showing normal development, adapting adequately and progressively to its environment, should have even a nodding acquaintance with analysts. The rigidity of a systematised educational scheme must of necessity fail to win response from a minority of children, and this coupled with an adverse family environment accounts for the mal-development of the few. Among this group of potential neurotics, criminals, and chronic failures lies the sphere of usefulness of the child analyst.

Dr. Pearson declared that analysis itself is not curative, but by exposing the causal factors of the mal-development it is a means of pointing the way to constructive methods of treatment. He described three cases in which analytical methods had been used, to illustrate how they had been treated. The subsequent history of each child showed how by co-operation with the teacher a definite cure had followed. He believed that in co-operation lies the future of psycho-analysis in its practical value to school life, and that the knowledge gained in dealing with the abnormal would be of inestimable importance in dealing with, and understanding, the normal.

Dr. R. G. Gordon endorsed the value of co-operation of the workers in the fields of education and psychology, and also emphasised the necessity that such problems should be dealt with only by people whose knowledge is extensive, and embraces such collateral subjects as physiology and biology. He protested strongly against the unqualified dabbler with his pseudo-metaphysical speculations which are not even logical.

Dr. Gordon described two types of children likely to give trouble, namely, the psycho-pathic child, and the retarded child who is yet not sufficiently feeble-minded to be classed as mentally deficient. Every child inherits certain predispositions, and some dispositions unmodified or uncontrolled are evil and lead to vicious conduct, but if properly correlated, and modified by each other, and by education, they are all capable of leading to the highest virtues. It is the uncontrolled impulses which characterise the behaviour of the moral deficient, such as an overmastering impulse of acquisitiveness and a complete failure to get into touch with reality.

The retarded child is a slightly different problem. If with an intellectual inferiority he possesses a nature in which self-assertion is a large factor, he will not submit to inferiority—superiority at games may save his self-respect, but in their absence his will to assertion may show itself in acts of rudeness, disobedience, or stubbornness. To avoid punishment he becomes a liar; to prove his independence he plays truant; and possibly to further his object he may steal money, etc. Other undesirable traits may exhibit themselves in his efforts to gain ascendancy over other children. In many cases it is only necessary to remove such children from the unfair competition involved in school, and start them in training suited to their intellectual capabilities. Not only will this do away with all vicious tendencies, but it will increase their achievement to a remarkable degree, so that they grow up not incapable of taking a worthy place in the world. Neglect of proper treatment for such children means that they eventually enter the ranks of the neurotic or the criminal, or may turn to drink or drugs which lead to an abased and useless life. It is obvious that investigation and treatment of such cases should be definitely undertaken both for the sake of the individual and of the State.

The investigation should be carried out in three directions: (1) the physical examination—a purely medical concern; (2) the intelligence estimate through the use of such means as the Stamford revision of the Binet-Simon tests, etc.; and (3) the child's reaction to life—requiring mental exploration. In the last case Dr. Gordon said if clinics are established it must be borne in mind that only properly qualified workers should conduct the inquiry. The mind of the child is a delicately adjusted mechanism and cannot be too carefully handled; the greatest care must be taken that nothing shall be implanted which shall still further weaken control and upset the nice adjustment of impulses on which his or her sanity depends. The functions of such clinics will at first be purely advisory, and here the importance of sound advice is obvious.

In schools of all types are to be found children whose moral sense and will to work are so impaired that their time at school and probably at home is a succession of misdemeanours and acts of viciousness, a continued refusal to adapt themselves to social order; they are deaf to all appeals to reason. The investigation of the problems set by these children seems to be rightly in the hands of the psychologist, and the present inquiry is to learn to what extent mental exploration in the form of psycho-analysis can save the child by pointing out the cause and thus suggesting the remedy. Every speaker expressed the opinion that this inquiry should only be undertaken by a fully qualified specialist and should be limited to those children who were abnormal in their behaviour and in their response to the usual incentives to work.

Corrosion and Colloids.[1]

CORROSION is defined as the oxidation of a substance; it may be produced by chemical or electrochemical means. The following facts are difficult to explain on a purely electro-chemical theory of corrosion: (*a*) Certain depolarisers do not increase corrosion, but actually inhibit it; (*b*) the conductivity of electrolytes is not directly connected with the amount of corrosion; (*c*) Lambert's pure iron is readily attacked by sodium chloride solution and dilute acids; and (*d*) the presence of ions of the corroding metal sometimes increases corrosion. The order of corrodibility of metals in distilled water, certain salt solutions, and non-electrolytes is different from their order in the electro-chemical list; this suggests that there are factors interfering with the electro-chemical action. Such factors are scale formation, and the nature and distribution of the products of corrosion.

The effects of strain and impurity in the metal are considered on the electro-chemical view to be of fundamental importance. Experiments on Lambert's

[1] Abstract of sixth report of the Corrosion Research Committee of the Institute of Metals, presented by Dr. G. D. Bengough and J. M. Stuart at the Swansea meeting of the Institute on September 20.

pure iron and lead showed that the effect of strain is a minor and ephemeral factor in corrosion in neutral solutions; a trace of impurity appears to assist local corrosion, but the amount of corrosion is not proportional to the amount of impurity. The effect of a trace of impurity is probably a trigger action. The main function of oxygen in corrosion is not that of a depolariser, but rather to oxidise the metal directly, and also in some cases the products of corrosion.

Two chief types of corrosion are distinguished: (*a*) The general type, usually characteristic of acid corrosion; and (*b*) the local type, usually characteristic of corrosion in water and salt solutions. The latter is generally characterised by the formation of an adherent scale on the metal, which may contain colloid. The significance of colloids in corrosion appears to be as follows: A metal immersed in water sends positively charged metal ions into the liquid, and becomes itself negatively charged. With commercial metals, the metal also becomes superficially oxidised if dissolved oxygen is present. The hydroxide produced can take up the ions given off by the metal, and thereby becomes a positively charged colloid. Some of this will diffuse away, permitting further reaction between oxygen and the metal surface. Oxidation stops until this hydroxide can pass into the colloidal state by acquiring positively charged metal ions. This, in general, does not take place till the colloid initially formed has diffused into the presence of electrolyte, when it is precipitated by the anion of the dissolved salt, the cation neutralising the charge on the metal corresponding to that on the colloid. Then the metal can send more ions into solution, and the uncharged hydroxide can acquire a charge. If the colloid produced can diffuse away, the process can continue and corrosion develop. If the colloid precipitates directly on the corroding surface it will, in general, adhere and stop corrosion. In the case of a corrosion pit, it is only when the colloid diffuses through an aperture in the gel-deposits at the mouth of the pit that it meets electrolyte and is then precipitated. Such precipitation merely thickens the external gel-deposits. The latter protect the metal surrounding the pit, and emphasise the local nature of the corrosion.

Vitamins.

THE Sections of Physiology and Agriculture of the British Association held a joint discussion on vitamins at Hull on Friday, September 8.

Prof. J. C. Drummond spoke of the great strides that have been made since the discovery of the vitamins by Hopkins in 1912. Both the existence and the indispensability of these substances are now generally accepted. The far-reaching importance of the qualitative composition of the diet of man and animals is being gradually appreciated, and the significance of those factors which exist in extremely minute amounts recognised. Three substances of the so-called vitamin class have been differentiated with certainty, and it is possible that more exist. They do not appear to be of one chemical type, and the only ground for grouping them together is that they occur, and are effective, in very small amounts. Parallel examples from the inorganic food constituents are known, such as the value of minute doses of iodides in the treatment and prevention of fœtal athyrosis in swine.

The green tissues of plants would seem to be the chief site of vitamin synthesis, although lower forms of plant life devoid of photocatalytic pigments can apparently produce the vitamin B. Plant tissues undoubtedly form the direct or indirect source of the vitamin supply of animals, but we are entirely ignorant as to the rôle of the vitamins in the plant itself.

Storage of the vitamin A may take place in the tissues, liver, and body fat of animals, and may serve as a reserve from which are drawn supplies to maintain the vitamin concentration of milk if the diet during the lactation period should be deficient.

In collaboration with Dr. Zilva a prolonged investigation of the origin of the large stores of vitamin A in cod-liver oils has recently been made. It has been ascertained that the marine diatoms synthesise the vitamin, and that it is transferred to the tissues of minute animals (plankton) which thrive on the unicellular plants. These in turn form the food supply of larger species, particularly small fish, which in their turn are devoured by the larger fish, such as the cod. Through all these stages there is apparently a transference of the vitamin, ending finally in the storage in the liver of the cod. The modern methods of manufacture of cod-liver oil do not appreciably lower the vitamin value, but there are wide variations in the value of different samples which are probably connected with the seasonal changes in the feeding habits or physiological condition of the fish. Considerable work has been done on the chemical nature of the vitamin A, but an isolation has not yet been made. It is very stable, except to oxidative changes, and passes into the unsaponifiable fraction of the oil. Cholesterol, pigments, and other fractions of this fraction may be removed without loss of potency.

Capt. J. Golding gave a number of illustrations of the value of the application of vitamin theories in practical pig-feeding. Frequently the usual type of pig diet is deficient in vitamins, particularly vitamin A, and the beneficial influence of cod-liver oil or of feeding on pasture or lucerne in such cases is remarkable. In the compounding of rations care should be taken to ensure an adequate supply of food-stuffs rich in vitamins, otherwise there is danger of subnormal growth, impaired resistance to infections, and disturbances of the power to produce and rear normal young. The majority of the cereal products are deficient in vitamin A, and the amount in the diet is not raised much by the use of separated milk. Such diets can be supplemented by small additions of cod-liver oil, 1-2 oz. daily for full-grown pigs, or by access to pasture. Cod-liver oil is also valuable in maintaining the vitamin value of the milk yielded by cows on winter rations in stall, which otherwise tends to fall. The administration of cod-liver oil, if of good quality, does not produce flavour or taint in pigs or milk and butter.

Dr. Atherton Seidell (New York) described his attempts at the separation of the vitamin B from yeast by chemical methods. By adsorption of the vitamin from yeast extracts on to fuller's earth, and extraction of the activated solid with alkalies under suitable conditions, considerable concentration of the active substance could be effected. The resulting extract when fractionated by precipitation with silver salts gave active fractions, but these have not yet yielded a pure substance.

Prof. W. D. Halliburton referred to the need for caution that enthusiasm for a new word such as vitamin did not overwhelm the importance of other dietary units. There must not be a loss of perspective in viewing the function of these newly

discovered substances. There is also need for further research on the nature of the substances (auximones) which are believed to act as vitamins for plant growth.

Dr. Monkton Copeman agreed with the importance of vitamins for the young and growing organism, but questioned whether they are as important, or not actually deleterious, to the mature animal. In some researches which had recently been made under the auspices of the Ministry of Health, evidence had been obtained that patients suffering from malignant growths had received benefit from a course of feeding on dietaries deficient in vitamins. There was also a definite, if microscopic, fall in the Registrar-General's figures for cancer during the years of the war, when food restrictions were in force.

British and American Fine Chemicals.

THE "Catalogue of Chemical Products" issued by the British Drug Houses, Ltd., is now so well known to chemists that there is little need to do more than direct attention to the new edition, issued on September 21, which includes several thousand chemicals, many of them recent additions. The firm caters not only for chemical laboratories, but also supplies an extensive range of requisites for microscopic work, such as stains, mounting media, embedding materials, liquids of known refractive index, etc. Special mention may be made of the list of about 50 indicators for which the catalogue gives a useful table showing the PH range in each case, including the universal indicator, a mixture to be used for determining rapidly and in one operation the approximate PH of a solution by the colour developed.

A new edition (No. 8) of the list of organic chemicals sold by the Eastman Kodak Co. in the United States has also been issued recently. It includes about 1400 products and has two good features which British firms might copy with advantage. It indicates, usually by means of the melting- or boiling-point, the degree of purity of the product, and states which materials have been made or purified in the firm's own laboratories. The American firm seems to realise the necessity of securing as quickly as possible a reputation for quality similar to that enjoyed by a few of the German makers before the war, and the features just alluded to have no doubt been introduced into their list with that object.

The Eastman list begins with an introduction in which, after recording progress, a frank appeal is made to chemists to co-operate with the company in making the United States independent as regards the supply of these essential materials, by indicating possible means of improving the quality, furnishing information as to supplies of new or rare organic chemicals available for purchase, and suggesting new materials for manufacture.

British manufacturers should realise that British chemists are equally interested in this matter so far as this country is concerned, and similar appeals in their lists would probably have an excellent effect. There are few research laboratories in which there are not residues of rare organic chemicals available for disposal, and most laboratories of university standing could, from time to time, do something towards supplying complex organic chemicals.

It has been urged against the Board of Trade lists drawn up under the Safeguarding of Industries Act that they "protect" many chemicals which, owing to the small demand and the cost of labour, can never be made in this country. The co-operation of university laboratories might also be a means of overcoming this difficulty.

University and Educational Intelligence.

CAMBRIDGE.—Mr. E. C. Francis, Trinity College, has been elected Fellow and mathematical lecturer at Peterhouse. Mr. C. G. Lamb has been appointed reader in electrical engineering.

The allotment made in 1920 of 165,000*l.* for the endowment of the School of Biochemistry from the estate of the late Sir William Dunn has been increased by a further sum of 45,000*l.* It is of interest to note the allotment ordered by the Court for the subdivision of the total sum of 210,000*l.*, namely (*a*) 96,000*l.* for the site and building of the Institute of Biochemistry; (*b*) 18,000*l.* for equipment, maintenance, and improvements out of annual income; (*c*) 89,000*l.* for salaries and the expenses of research work out of annual income; (*d*) 7000*l.* for a fund to meet contingencies and unforeseen expenditure.

A studentship for study and research in the languages, literature, history, archæology or art of ancient Greece or Rome or the comparative philology of the Indo-European languages is to be founded from a bequest under the will of the late Sir John Sandys, Public Orator.

MANCHESTER.—On Monday, October 30, Mr. Harold L. Cohen opened the Lewis Departmental Library in the Faculty of Commerce and Administration. This library, and also certain scholarships, have been provided from a gift by Messrs. Lewis with the object of encouraging co-operation between the university and the business community of the city. The Faculty of Commerce has made rapid progress during recent years, and it is hoped that university graduates may find increasing opportunities to demonstrate the value of a university training in commerce.

Mr. E. J. Sidebotham has been appointed honorary lecturer in public health, and Mr. G. J. Langley hon. assistant lecturer in physiology.

The following appointments have also been made: assistant lecturer in electrical engineering, Mr. L. S. Palmer; special lecturer in textile design, Mr. Henry Cadness; Osborne Reynolds fellow, Mr. F. D. Reynolds; Vulcan fellow, Mr. F. Heywood; Leech fellow, Mr. C. D. Hough.

ST. ANDREWS.—The University Court has now made an appointment to the chair of natural philosophy in the United College, which became vacant at the end of last academical year by the retirement of Prof. Butler. The new professor is Dr. H. Stanley Allen, of the University of Edinburgh. Dr. Allen was educated at Kingswood School, Bath, and Trinity College, Cambridge. Afterwards he held a post as assistant lecturer at the University College of Wales, Aberystwyth; he also did research work in physics at the Cavendish Laboratory, Cambridge, under the direction of Sir J. J. Thomson, and was in charge of Lord Blythswood's physical laboratory at Renfrew. In October 1905 Dr. Allen was appointed to a post in the physics department of King's College, London, where, after being lecturer for some years, he followed his chief there (Prof. C. G. Barkla) to the physics department in Edinburgh. In the course of his career Dr. Allen has had a varied experience of the teaching of physics, and he has made some notable contributions to the scientific literature of the subject.

THE following Parliamentary candidates for university constituencies have been returned unopposed:—Scotland: D. M'Coig Cowan (N.L.), Sir Henry Craik (U.), and Sir George Berry (U.). Queen's, Belfast: Sir William Whitla (U.). Sir George Berry is the only new member from these two constituencies.

Calendar of Industrial Pioneers.

November 12, 1902. William Henry Barlow died.—Appointed principal engineer of the Midland Railway in 1844, when thirty-two years of age, Barlow laid out the line from London to Bedford and was responsible for St. Pancras Station. He was also concerned with the Clifton Suspension Bridge, the second Tay Bridge, and the Forth Bridge. He was widely known for his scientific investigations of arches and beams, and in 1868 was made one of the committee appointed to investigate the applicability of steel to structures. He was a vice-president of the Royal Society, and in 1879–80 president of the Institution of Civil Engineers.

November 13, 1903. Josiah Vavasseur died.—One of the chief ordnance engineers of last century, Vavasseur invented in 1866 the copper rotating ring or band for projectiles of breech-loading guns, and subsequently did important work on the construction of built-up steel guns and on hydraulic mountings. In the Vavasseur mounting of 1877, the recoil was for the first time scientifically controlled by hydraulic buffers having a uniform resistance. The London Ordnance Works which he founded was in 1883 merged in those of Armstrong's at Elswick.

November 14, 1830. Henry Bell died.—The foremost pioneer of the steamboat in Europe, Bell, who was born at Torphichen, Linlithgowshire, on April 7, 1767, was apprenticed as a stone mason but afterwards became a shipwright and builder. In 1808 he, became proprietor of a hotel and baths at Helensburgh on the Clyde and in 1811 ordered the *Comet*. In August 1812 this little craft began running between Glasgow and Greenock, and from this dates the beginning of steam navigation in Europe. The vessel was wrecked in 1820, but the engine was salved and is preserved in the Science Museum at South Kensington.

November 14, 1905. Robert Whitehead died.—The inventor of the automobile torpedo, Whitehead made his first torpedo in 1866 while holding a position in an engineering works at Fiume. Taken up first in 1868 by the Austrian Navy, experiments were carried out at Sheerness in 1870 and soon afterwards the torpedo was adopted by the British and other Governments.

November 15, 1839. William Murdock died.—Known principally for his discovery of lighting by coal gas and as the originator of a great industry, which in Great Britain alone consumes some 22,000,000 tons of coal per annum, Murdock was for many years the right-hand man of Boulton and Watt. He was first employed by them in 1777, and was sent to Cornwall to erect steam engines. In his house at Redruth in 1784 he experimented with a small locomotive and in 1792 lighted his house by gas. He was also a pioneer in the transmission of power by compressed air.

November 16, 1911. Engelbert Arnold died.—A notable contributor to the literature of electrical engineering, Arnold, after studying at Zürich, engaged in practical work in Russia. For a short time he was engineer to the Oerlikon works in Switzerland and from 1894 to 1911 held a chair at the Institute of Technology at Karlsruhe.

November 18, 1814. William Jessop died.—Trained as a civil engineer under Smeaton, Jessop was employed on some of the English canals, completed the West India Docks and constructed a railway in Surrey which was the first opened to the public in the South of England. E. C. S.

Societies and Academies.

LONDON.

Royal Society, November 2.—Sir Charles Sherrington, president, in the chair.—Lord **Rayleigh**: Polarisation of the light scattered by mercury vapour near the resonance periodicity. White light scattered at right angles by dense mercury vapour is to a first approximation completely polarised. Ultra-violet radiation of the mercury spectrum line $\lambda 2536$, when examined immediately it enters mercury vapour in an exhausted vessel at room temperature, gives a scattered radiation which is slightly though definitely polarised. This polarisation has been observed to increase as the beam is filtered by penetration of a considerable depth of vapour. After penetration of 27·5 cm. of vapour the weaker polarised image had 60 per cent. only of the intensity of the stronger one, instead of 90 per cent. as at first. The radiation removed by the filtration appears to lie within a spectral range of about 1/100 Ångstrom.—G. P. **Thomson**: The scattering of hydrogen positive rays and the existence of a powerful field of force in the hydrogen molecule. At a pressure of less than 1/100 mm., hydrogen positive rays of 10,000 volts mean energy suffer considerable small-angle scattering in a distance of 15 cm. This scattering is 10-20 times greater than would be expected on theoretical grounds. There must, therefore, be a field of force in the hydrogen molecule at distances of the order of 10^{-8} from a nucleus which is much stronger than would be expected from the inverse square law. A subsidiary experiment throws great doubt on Glimme and Koenigsberger's "Stossstrahlen."—H. D. **Smyth**: A new method for studying ionizing potentials. Positive ray analysis is used to study the ions produced in a gas or vapour by the impact of slow-speed electrons of known energy. This requires that the density of gas be considerable where the energy of the impacting electrons is known, and as small as possible where the energy conditions are not known. In the case of mercury such a localisation of vapour density was obtained by using a unidirectional molecular stream similar to that employed in a mercury diffusion pump. Ions were produced by electrons from a hot filament, and after acceleration by a large electric field were analysed by a magnetic field. In this way the values of m/e were determined approximately. The experiments on mercury indicate the formation of doubly charged ions at 19 ± 2 volts. The series relations of the enhanced spectrum of mercury are not known, but analogy with zinc and cadmium suggests an estimate in agreement with the above value. The conclusion is that the double ions formed at this voltage are the result of two impacts. Experiments at higher voltages indicate formation by single impacts. More highly charged ions were present in such small quantities as to make their identification uncertain even at voltages as high as five hundred. It was also impossible to identify a singly charged diatomic molecule.—I. **Backhurst**: Variation of the intensity of reflected X-radiation with the temperature of the crystal. General agreement only is found with the theories of C. G. Darwin and P. Debye. Aluminium: Very marked decrease in intensity was observed with rise of temperature, and fair agreement with P. Debye's theory obtained for the (100) and (222) spectra. Carborundum: A special furnace was constructed for temperatures up to 960° C. and no deterioration of the crystal was observed. The decrease in intensity with rise of temperature was

much greater for the higher-order spectra, and different curves were obtained for the K α (333) and K β (333) spectra. Graphite: Only for the cleavage-plane reflection was it possible to obtain a definite temperature-intensity curve, and for the direction perpendicular to this plane an unusually high coefficient of expansion was measured. Diamond: No decrease in intensity was found that could be measured with certainty, and a very small thermal agitation would be expected on account of the diamond structure's great strength. Ruby and sapphire: An anomalous effect was observed, since the decrease of intensity of the (111) spectra was greater than that of the (222). This may be completely explained by assuming that the atoms of the aluminium pair remain in contact and do not share in the expansion of the lattice.—S. **Datta**: The absorption spectrum of potassium vapour. The principal series lines up to $m=42$ have been observed as absorption lines and their wave-lengths accurately measured. The series equation shows satisfactory agreement between the observed and the calculated values, with the exception of deviations for the last few lines, for which a possible explanation has been given. The first seven members of the series have been resolved into their components. Besides the absorption of the lines of the principal series, new lines have been found to be absorbed at higher pressures, which seem to have no correspondence with the known lines in the emission spectrum. The combination lines $1s-2d$ and $1s-3d$ have been found to be absorbed, the first as a pair, confirming the presence of a satellite to the lines of the diffuse series. Their appearance in the absorption spectrum gives distinct evidence of contradiction of the selection principle. — K. R. **Ramanathan**: The molecular scattering of light in vapours and in liquids and its relation to the opalescence observed in the critical state. Three instances of light scattering by homogeneous media are known—opalescence near critical point, scattering of light by gases, and scattering of light by liquids. Experiments on scattering of light by ether, in vapour and liquid phases, at different temperatures from 33° C. up to critical temperature 193·6° and in gaseous phase from 193·6° to 217°, give results in accord with the Einstein-Smoluchowski formula and not with the Rayleigh law. The Einstein-Smoluchowski formula is inapplicable in *immediate neighbourhood* of critical point. The scattered light is markedly less blue here. Following the theoretical work of Ornstein and Zernike, from maximum value of intensity of scattered light the value of ϵ, radius of action of ether molecule, is deduced to be $4 \cdot 6 \times 10^{-7}$ cm. Light scattered at right angles to incident beam is imperfectly polarised; ratio of weak component to strong is throughout nearly 1·2 per cent., in case of vapour, while in case of liquids, ratio is 8 per cent. at ordinary temperatures, remaining constant till about 120° and then falling off to about 1·2 per cent. at critical point. There is no change of imperfection of polarisation on passing through critical point. Correction due to this in the expression for intensity of scattered light is given.

PARIS.

Academy of Sciences, October 16.—M. Albin Haller in the chair.—The president announced the death of F. P. A. Barbier, correspondant for the section of chemistry.—Maurice **Hamy**: The calculation of a double integral which occurs in the theory of the diffraction of solar images by a rectangular slit.—An. **Bilimovitch**: The lines of inertia on a surface.—Ed. **Le Danois**: The hydrology of the North Atlantic. It is considered that the name Gulf Stream should be restricted to the return current from the equatorial region. The variations in temperature and salinity of the surface water are due to a seasonal phenomenon and not to ramifications of the Gulf current.—C. **Raveau**: Demonstration of Fresnel's law of æther drift, without reference to the relativity of time and space.—André **Guilbert**: The calculation of the attraction of electro-magnets. —Maurice **Curie**: The refractive indices of the phosphorescent sulphides. The refractice indices of phosphorescent sulphides of calcium, strontium, barium, and zinc have been measured directly by the observation under the microscope of particles of the sulphides in a transparent homogeneous liquid of the same refractive index. The values found differ considerably from the square root of the dielectric capacity and lend no support to the theory of P. Lénard.—L. J. **Simon** and L. **Zivy**: The neutralisation of tartaric acid by potash in presence of the chlorides of the alkaline earths. In the presence of calcium (or barium) chloride, the titration of tartaric acid requires the same volume of caustic potash solution for neutralisation with either methyl orange or phenolphthallin as indicator. — Albert **Perrier** and B. **de Mandrot**: The elasticity and symmetry of quartz at high temperatures. Flat plates were cut from quartz crystals in four directions: along the binary and ternary axes, then in two directions normal to the binary axis. The quartz plates were worked with optical precision and the flexures caused by a load at the centre determined for temperatures ranging from 18° C. to 1140° C. There is a rapid change in the value of Young's modulus at 576° C., a rise of 1° increasing the modulus to three times its value. Aimé **Azam**: The origin and process of formation of the soils at the Hague.—Jean **Mascart**: The proportion of successes in weather prediction. The question as to what constitutes a successful weather prediction is discussed, and it is pointed out that many predictions are too vaguely drawn and cover too many possibilities. If the forecast is drawn in precise terms, weather prediction may be considered satisfactory if the proportion of successes is more than 60 per cent.—P. **Bugnon**: The systematic position of the Euphorbiaceæ. J. **Beauverie**: The "critical period of wheat."—L. **Blaringhem**: A sterile hybrid of spelt and rye.—Adrien Davy **de Virville** and Fernand **Obaton**: Observations and experiments on ephemeral flowers. Light has no action on the opening or closing of the corolla in ephemeral flowers, and hygrometric state has a very slight influence. The temperature is the main factor in these movements. —Marc **Bridel** and Mlle. Marie **Braecke**: Rhinanthine and aucubine. Rhinanthine is impure aucubine. Rhinanthine was extracted by Ludwig from the seeds of *Rhinanthus Crista-galli*, and aucubine was discovered by Bourquelot and Hérissey in the seeds of *Aucuba japonica*. Rhinanthine is regarded by the authors as a mixture of saccharose and aucubine, and experimental data are given in support of this view.—Fred **Vlès**: The variations of the hydrogen ion concentration in the neighbourhood of eggs undergoing division.—J. **Legendre**: The trophic rôle of birds as regards the culicines. Further studies on the part played by domestic animals and birds in the protection of man against insects (Culex, Stegomyia).—Paul **Wintrebert**: Movement without nerve and nervous movement of the embryos of Raia.—A. **Gruvel**: Two species of lobster from the coasts of Indo-China.—J. **Dumas** and D. **Combiesco**: Dysenteric intoxication of the rabbit and cholera intoxication of the guinea-pig by ingestion of soluble dysenteric and cholera toxins.

Official Publications Received.

Journal of the College of Science, Imperial University of Tokyo. Vol. 42, Art. 3: Ökologische Untersuchungen der Schwimminseln in Japan. Von Harufusa Nakano. Pp. 57. 1.50 yen. Vol. 44, Art. 1: Fossils from the Upper Musashino of Kazusa and Shimosa. By Matajiro Yokoyama. Pp. 200+viii+17 plates. 9.20 yen. Vol. 44, Art. 2: On some Japanese Freshwater Triclads; with a Note on the Parallelism in their Distribution in Europe and Japan. By Tokio Kaburaki. Pp. 71+1 plate. 2.30 yen. (Tokio: Imperial University; Maruzen Co., Ltd.)

Philosophical Transactions of the Royal Society of London. Series B, Vol. 211: The Breeding Places of the Eel. By Dr. Johs. Schmidt. Pp. 179-208. (London: Harrison and Sons, Ltd.)

Actes de la Société Helvétique des Sciences Naturelles. 101e Session annuelle du 29 août au 1er septembre 1920 à Neuchatel. 1re Partie. Pp. 266+55. (Aarau: H. R. Sauerländer et Cie.)

Bulletin of the American Museum of Natural History, Vol. 46, Art. 10: The Locomotor Apparatus of certain Primitive and Mammal-like Reptiles. By Alfred Sherwood Romer. Pp. 517-606+plates 27-46. (New York: American Museum of Natural History.)

Contributions from the Jefferson Physical Laboratory, from the Cruft High-Tension Electrical Laboratory, and from Colleagues and Former Students, dedicated to Professor Edwin Herbert Hall, for the Year 1921. Vol. 15 (unpaged). (Cambridge, Mass.: Harvard University Press.)

The Institution of Civil Engineers. Engineering Abstracts prepared from the Current Periodical Literature of Engineering and Applied Science, published outside the United Kingdom. New Series, No. 13, October. Edited by W. F. Spear. Pp. 176. (London: Institution of Civil Engineers.)

República Argentina. Ministerio de Agricultura de la Nación: Oficina Meteorologica Nacional. La Máxima de la radiación solar en Enero y Febrero de 1920, y el estado del tiempo mundial. Por H. H. Clayton y Guillermo Hoxmark. Pp. 18. (Buenos Aires.)

Rapport annuel sur l'état de l'Observatoire de Paris pour l'année 1921. Par M. B. Baillaud. Pp. 35. (Paris: Impr. Nationale.)

Canada. Department of Mines: Mines Branch. No. 549: Report on Structural Materials along the St. Lawrence River, between Prescott, Ont., and Lachine, Que. By Joseph Keele and L. Heber Cole. Pp. 119+30 plates+3 maps. (Ottawa.)

Nedbøriakttagelser i Norge utgitt av det Norske Meteorologiske Institutt. Årgang 27, 1921. Pp. xiii+79+47+2 maps. (Kristiania: H. Aschehoug and Co.) 6.00 kr.

Jahrbuch des Norwegischen Meteorologischen Instituts für 1921. Pp. xi+174. (Kristiania: Gröndahl and Sön.)

Field Museum of Natural History. Publication 210, Zoological Series, Vol. 12, No. 3: Game Birds from North-western Venezuela. By W. H. Osgood and B. Conover. Pp. 17-48. (Chicago.)

Annual Conference of the Universities of Great Britain and Ireland, 1922. Abridged Report of Proceedings. Pp. 32. (London: Universities Bureau of the British Empire.) 1s.

Nedbøriagttagelser i Norge utgit av det Norske Meteorologiske Institut. Middelværdier, Maksima og Minima. Pp. xvi+xi+88+12 plates+2 maps. (Kristiania: H. Aschehoug and Co.) 6.00 kr.

State of Illinois. Department of Registration and Education: Division of the Natural History Survey. Bulletin, Vol. 13, Art. 14: Forest Insects in Illinois. I.: The Subfamily Ochthiphilinæ (Diptera, Family Agromyzidæ). By J. R. Malloch. Pp. 345-362. Bulletin, Vol. 13, Art. 15: The Small Bottom and Shore Fauna of the Middle and Lower Illinois River and its Connecting Lakes, Chillicothe to Grafton; its Valuation; its Sources of Food Supply; and its Relation to the Fishery. By R. E. Richardson. Pp. 363-522. Bulletin, Vol. 13, Art. 16: An Ecological Survey of the Prairie Vegetation of Illinois. By H. C. Sampson. Pp. 523-578+plates 48-77. Bulletin, Vol. 14, Art. 1: The Orchard Birds of an Illinois Summer. By S. A. Forbes and A. O. Gross. Pp. 8+6 plates. Bulletin, Vol. 14, Art. 2: Distribution of the Fresh-water Sponges of North America. By F. Smith. Pp. 9-22. (Urbana, Ill.)

República Argentina. Ministerio de Agricultura de la Nación: Oficina Meteorologica Nacional. Las Condiciones físicas del Atlántico Sur entre et Río de La Plata y las Islas Orcadas del Sur durante el verano. Por R. C. Mossman. Pp. 26. (Buenos Aires.)

University of London: University College. Calendar, Session 1922-1923. Pp. lxviii+410+lxix-clxxxviii. (London: Taylor and Francis.)

Annuaire de l'Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique. 1922, 88e année. Pp. 124+209+plates. (Bruxelles: M. Lamertin; M. Hayez.)

Ministry of Agriculture, Egypt. Cotton Research Board. Second Annual Report, 1921. Pp. xvi+203. (Cairo: Government Publications Office.) 15 P.T.

Bulletin of the American Museum of Natural History. Vol. 45, III.: The Predaceous Enemies of Ants. By J. Bequaert. Pp. 271-331. Vol. 45, IV.: Ants in their Diverse Relations to the Plant World. By J. Bequaert. Pp. 333-583. Vol. 45, V.: The Anatomy of certain Plants from the Belgian Congo, with Special Reference to Myrmecophytism. By I. W. Bailey. Pp. 585-621. Vol. 45, VI.: Notes on a Collection of West African Myrmecophiles. By W. M. Mann. Pp. 623-630. Vol. 45, VII.: Keys to the Genera and Subgenera of Ants. By W. M. Wheeler. Pp. 631-710. Vol. 45, VIII.: A Synonymic List of the Ants of the Ethiopian Region. By W. M. Wheeler. IX.: A Synonymic List of the Ants of the Malagasy Region. By W. M. Wheeler. Pp. 711-1055. (New York.)

Jamaica. Annual Report of the Department of Agriculture for the Year ended 31st December 1921. Pp. 43. (Kingston, Jamaica.)

Studies on the Cyclostomatous Bryozoa. By F. Canu and R. S. Bassler. (No. 2443: From the Proceedings of the United States National Museum, Vol. 61, Art. 22.) Pp. 160+28 plates. (Washington: Government Printing Office.)

Diary of Societies.

MONDAY, NOVEMBER 13.

ROYAL SOCIETY OF ARTS, at 8.—J. Slater: The Strand and the Adelphi in Ancient Times.
ENTOMOLOGICAL SOCIETY OF LONDON, at 8.
SURVEYORS' INSTITUTION, at 8.—J. M. Clark: Presidential Opening Address.
ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Commander F. Wild: The Work of "The Quest."

TUESDAY, NOVEMBER 14.

ROYAL HORTICULTURAL SOCIETY, at 3.—Dr. H. Wager: The Colours of Flowers and Fruits (Masters Memorial Lecture).
INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.
INSTITUTE OF MARINE ENGINEERS, INC., at 6.30.—J. Steinheil: The Evolution of the Nobel Diesel Engine (Part I.).
QUEKETT MICROSCOPICAL CLUB, at 7.30.—Dr. R. J. Ludford: The Cytology of Growth.
ILLUMINATING ENGINEERING SOCIETY (at Royal Society of Arts), at 8.—Reports on Progress during the Vacation and Developments in Lamps and Lighting Appliances.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—J. C. Kingdon: Experiments on the Tensile Strength of Gelatine and Gelatine-jelly; Discussion of the Results as bearing on the Structure of Gelatine; with a Note on the Evolution of Heat by Gelatine when expanding in Water.—K. C. D. Hickman: Rapid Sulphiding of Bromide Prints. Toning with Gases instead of Liquids; together with a Demonstration of the Methods employed.—D. Northall-Laurie: Photomicrographs in Colour mounted to exhibit changing Tints.

WEDNESDAY, NOVEMBER 15.

ROYAL MICROSCOPICAL SOCIETY, at 8.—C. Beck: Glare and Flooding in Microscope Illumination.—Dr. C. Singer: The First Mechanical Microtome.—Prof. G. S. Thapar: The Occurrence and Significance of a Third Contractile Vacuole in *Paramecium caudatum*.—Prof. B. L. Bhatia: The Significance of Extra Contractile Vacuoles in *Paramecium caudatum*.
ROYAL SOCIETY OF ARTS, at 8.—Dr. S. Smith: The Action of the Beater in Paper Making, with Special Reference to the Theory of the Fibre Board and its Application to Old and New Problems of Beater Design.

THURSDAY, NOVEMBER 16.

ROYAL SOCIETY, at 4.30.—*Probable Papers*.—Prof. A. S. Eddington, The Propagation of Gravitational Waves.—Dr. J. H. Jeans: The Theory of the Scattering of α and β Rays.—Prof. A. P. Chattock and L. F. Bates: The Richardson Gyro-magnetic Effect.—P. M. S. Blackett: The Analysis of α Ray Photographs.—J. H. Jones: The Kinetic Energy of Electrons emitted from a hot Tungsten Filament.—Dr. W. Wilson: The Quantum Theory and Electro-magnetic Phenomena.—S. Marsh and A. E. Evans: Measurements of Electrode Potential Drop with Direct Current and Alternating Current Electrolysis.
LINNEAN SOCIETY, at 5.
ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—R. McKinnon Wood: The Co-relation of Model and Full-Scale Work.
CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—A. D'Arcy Chapman: The Measurement of the Intelligence of School Children in Massachusetts, U.S.A.
INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—The late Dr. G. Kapp: The Improvement of Power Factor (read by Prof. M. Walker).
CHEMICAL SOCIETY, at 8 (and Informal Meeting).
CAMERA CLUB, at 8.15.—T. H. B. Scott: Lourdes.

FRIDAY, NOVEMBER 17.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—J. W. Meares: The Development of Water Power in India.
INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Adjourned discussion on paper by Sir Vincent L. Raven: Electric Locomotives.
JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—Annual General Meeting.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 8.—N. E. Luboshez: Definition and Diffusion of Image.

PUBLIC LECTURES.

SATURDAY, NOVEMBER 11.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. W. A. Cunnington: The Natural History of Crabs.

MONDAY, NOVEMBER 13.

CITY OF LONDON Y.M.C.A. (186 Aldersgate Street), at 6.—Sir Bruce Bruce-Porter: How to Keep Well.

TUESDAY, NOVEMBER 14.

SCHOOL OF ORIENTAL STUDIES, at 5.—Dr. T. G. Bailey: The Sansis, or Thieves of India: Their Language, History, and Customs.
ROYAL SANITARY INSTITUTE, at 5.15.—Miss A. D. Muncaster: Some Hygienic Aspects of Food and Food Preparation. (1) The Hygiene of Raw Food (Chadwick Lecture).
GRESHAM COLLEGE, at 6.—W. H. Wagstaff: Geometry. Succeeding Lectures on November 15, 16, and 17.

THURSDAY, NOVEMBER 16.

UNIVERSITY COLLEGE, at 2.30.—Miss Margaret A. Murray: Recent Excavations in Malta.
KING'S COLLEGE, at 5.30.—M. Beza: The Story of Cupid and Psyche in Rumanian Folklore.

FRIDAY, NOVEMBER 17.

BEDFORD COLLEGE FOR WOMEN, at 5.30.—Miss K. M. Westaway: Plutarch: His Life and Writings.

SATURDAY, NOVEMBER 18.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—A. D. Howell Smith: Textiles and their History.

SATURDAY, NOVEMBER 11, 1922.

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Technical Institutions and the Board of Education.

THE Board of Education has issued a circular (1286) for the purpose of defining full-time teaching service within the meaning of the School Teachers (Superannuation) Act. The Board appears to find much difficulty in defining full-time teaching service—difficulty which would not be shared, we think, by the average layman.

It would seem to us that there are two classes of teachers—those who have chosen teaching as their profession and have taken up full-time appointments under an Education Authority, and those who are known as visiting teachers or part-time teachers, and attend at their educational institutions only in order to conduct the special courses for which they were appointed. Generally speaking, the latter individuals are members of some other profession and would not expect to be regarded as full-time teachers. We can believe that there may be a few border-line cases—but they would be relatively very few, and each case could be considered on its merits. But the Board of Education—or is it the Treasury?—cannot look at the matter in this broad light, and this circular is an attempt to define full-time teaching service. The circular indicates that the first essential for recognition of full-time teaching service should be a formal agreement between employer and teacher in which should be clearly set out the nature of the duties, whether they are wholly of a teaching character, the extent of the employer's claim upon the teacher's working hours, and the restrictions, if any, put upon the employment.

We should have thought that such an agreement would have been sufficient evidence of full-time teaching service, just as it would be sufficient evidence for any judge or jury. Indeed, it is even sufficient for the Board so far as head or assistant teachers on the ordinary staffs of elementary or secondary schools are concerned, but in the case of specialist teachers and of teachers in technical schools and colleges, many of which are of university rank, "it will be necessary to call . . . for information as to the actual teaching hours as evidence of their full-time employment." Teachers in technical schools and colleges have a genuine cause for complaint here—not only because their agreement cannot be regarded by the Board as sufficient evidence in itself, but also because of the nature of the additional evidence to be demanded.

Full-time teaching service consists essentially of two component parts: actual teaching before a class, and the subsidiary duties entailed by actual teaching. The proportional value of these components depends, most

obviously, upon the subject taught, upon the standard which is reached, upon the technicality of the subject, and upon the experimental preparation involved. Therefore it would be impossible for the Board to make any just assessment of the magnitude of the subsidiary duties entailed on a bare return of actual teaching hours. If the Board of Education is unable to accept an approved agreement as sufficient evidence of full-time service, then, in justice to the teachers of science and technology, it must have more information than would be given by a mere return of actual teaching hours.

The circular indicates that the specific preparation of lessons (as distinct from general study) would be regarded as a subsidiary duty entailed by actual teaching, and we would point out here that teachers of science and technology must spend a large amount of time in keeping in touch with modern developments in science, and with the even more rapid and more extensive developments of the applications of science to industry. The time absorbed to this end cannot be regarded fairly as general study of an independent kind; it cannot be considered as dissociated from the teaching service; and it cannot be described as non-essential.

The teacher of science and technology has a claim for very special consideration here, for, though we are prepared to admit that every teacher should and must spend time in general study and should keep in touch with modern developments, yet we cannot be expected to believe that the time which must be spent in keeping up with the development of, for example, Roman history, is comparable with that which must be spent in keeping in touch with the development of electrical engineering.

In this connexion we note with amazement that according to this circular (clause 7) research work will not be regarded as teaching service, and the time spent in research work would not be counted as teaching service for the purpose of the Superannuation Act. We can only hope that either our reading of the clause is wrong or that it has been badly phrased, and does not express the real intention of the Board. If the research work referred to is research work which a teacher is undertaking on behalf of some firm, and for which he is receiving remuneration, then it is quite reasonable to regard such work as private work and not as teaching service to the State. But if the clause means that all research work will be regarded as non-teaching service, then we must protest most emphatically in the interests of the State.

Is it not essential for teachers of science and technology to give a certain amount of attention to research work in order to keep in touch with modern developments? Are there not students doing research work in many of our technical institutions? Will the time spent by the teachers in these institutions in guiding and directing that work be regarded as of no service to the State? Surely that clause in the circular has been badly phrased: it is incredible that all research work in technical institutions should be banned, by order of the Board of Education! For many years the value of research by teachers has been impressed upon the governing bodies of our chief technical institutions, but if the Board holds that time spent upon such investigations, however stimulating the work may be to teacher or pupil, is to be excluded from the superannuation scheme as pensionable service, then the institutions will be thrown back to the state they were in twenty years ago.

We feel that this circular has been drawn up without sufficient consideration of what is involved in the teaching of scientific and technological subjects, and it would seem that there has not been sufficient regard for the special conditions of teachers of science and technology in our technical schools and colleges.

We are glad to note, however, that the circular has been sent out to local authorities, governing bodies, and others for their observations, and that the Board will not arrive at a final decision as to the application of the principles set out until these observations have been considered. We hope, therefore, to see very considerable amendment in the final form of the circular.

Internal Secretion.

Glands in Health and Disease. By Dr. B. Harrow. Pp. xv+218. (New York: E. P. Dutton and Co., 1922.) n.p.

Internal Secretion and the Ductless Glands. By Prof. Swale Vincent. Second edition. Pp. xx+422. (London: E. Arnold and Co., 1922.) 25*s.* net.

THE two books before us have not the same object or scope, but they appear equally to fulfil the purpose intended. On the whole, they may be said, along with Sir E. Sharpey Schafer's "Endocrine Organs," to be the most useful books on the subject in the English language, apart from the encyclopædic "Endocrinology" edited by Llewellys Barker. While that of Dr. Harrow is of a somewhat popular nature, assuming comparatively little physiological knowledge on the part of the reader, Prof. Swale Vincent's book has the more ambitious aim of a scientific presentation of the facts definitely known on the subject. This latter has therefore rather the character of a work of reference, and will be found very useful in this way. It is naturally not so easy to read as Dr. Harrow's book, which presents an admirable, connected account of the

subject and may be thoroughly recommended to all who wish for a critical statement of the problems which are attracting so much attention at the present time. It is to be hoped that those of us who have been misled by the wild reports of marvellous results published in the Press will adopt Dr. Harrow's cautious attitude and assess such reports at their proper value. Prof. Harvey Cushing, as quoted by Dr. Harrow, remarks:

"Nothing will discredit the subject so effectively as pseudo-scientific reports which find their way into advertising leaflets, where, cleverly intermixed with abstracts from researches of actual value, the administration of pluriglandular compounds is promiscuously advocated for a multitude of symptoms, real and fictitious. The Lewis Carroll of to-day would have Alice nibble from a pituitary mushroom in her left hand and a lutein one in her right hand and presto! She is any height desired!"

The title of Dr. Harrow's book, and also to a lesser degree that of Prof. Vincent's, invites some criticism. The name "gland" implies to the physiologist many organs and tissues which have functions other than that of producing substances for the purpose of exerting a particular action on other organs or tissues when they pass into the blood current. Those which form saliva and also the lymphatic glands may be mentioned. It is true that we might define a gland in a new way and say that any organ that produces some substance not already contained in the blood is entitled to the name. It would conduce to accuracy, however, if the name "gland" were limited to those organs able to pour out a secretion which can be collected and examined—those of "external secretion" in fact. In this case, the ductless "glands" would have to be called "bodies," or some similar name, as is indeed frequently done in speaking of the "pituitary body" or the "supra-renal bodies." The name "secretion" itself as applied to the activity of the endocrine organs is also not very satisfactory.

It must be confessed that we do not possess a really good name for these substances which act as "chemical messengers," formed by special cells for the special purpose, if the expression may be allowed, of producing an effect on another organ or cell when carried to it by the blood. A short word with the meaning of "chemical messenger" is what is wanted. When Prof. Starling and the present reviewer were engaged in investigating the mechanism of pancreatic secretion, we sought in vain for a word of this kind and were finally obliged to be satisfied with "hormone," although we felt that it was not exactly what we wished. It has, however, come into general use, although its meaning as "setting into activity" has caused the introduction of a number of other names, which might perhaps have been avoided. It is to be remembered that a messenger is sent for a special purpose, although he must take the road or railway which is in existence. Thus one of our hormones in the blood passes by a number of different cells before arriving at that kind which is sensitive to it, just as a letter sent by post is only received at that house to which it is addressed. A definition on the lines suggested would exclude such a constituent of the blood as carbon dioxide, called by Gley a "parhormone." Carbon dioxide would be produced by all active cells whether the respiratory centre happened to be sensitive to it or not. A train (the blood) carrying soldiers (carbon dioxide) to a port for foreign service (the outer air) might pick up men at various stations (organs of the body) through which it passed. At one station there might be on the platform a nursemaid (the respiratory centre) who greatly admired soldiers. She would be excited by the passage of the train, but it would scarcely be held that the soldiers were sent for that purpose. The development of the special sensibility of the respiratory centre is of course another question.

While each of the books before us is provided with a good index, Dr. Harrow alone gives a list of original works, which, however, does not profess to contain more than the most important ones. Considering that Prof. Vincent's book is especially valuable for reference, it seems unfortunate that he has omitted in this second edition the bibliography contained in the first. It may be putting too great a burden upon him, but it would have been of great service if he had given the titles of papers which seemed to him to contain definite new knowledge, rejecting those numerous ones which have no real value. Perhaps we might ask him to reprint in the next edition the original bibliography, adding to it papers which appeared up to 1915 and referring to *Physiological Abstracts* for the subsequent literature. Although many of the current text-books of physiology serve well for the use of junior students without references, it must not be forgotten that the more advanced of these books are often referred to by research workers and teachers, and information as to the place of more detailed description would greatly increase their value.

The great difficulty of exact research in the problems dealt with is impressed upon readers of either of the books before us. Sensational reports as to the transplantation of organs from one individual to another, or even from one species to a different one, are put in their proper place. It seems certain that individual characters are so highly marked, at all events in the higher mammals, that the only permanent grafting occurs when a tissue is taken from one part of an individual and planted in another part of the same individual. Occasional success has been obtained by L. Loeb between closely related persons, brothers for example.

Otherwise the graft always degenerates sooner or later. All the effect it has is the temporary addition of just that amount of the special hormone present in the cells of the graft when inserted. This appears to be the only basis of the much-talked-of transplantations of Prof. Voronoff.

That part of the subject about which the evidence is most conflicting is the interrelation of the various "ductless glands." Both books deal with this in a duly cautious manner. Prof. Vincent gives a valuable account of the morphology of the different organs and tissues. His views as to the nature of the Islets of Langerhans will perhaps not be generally accepted, but it must be admitted that he brings good evidence.

The only points in Dr. Harrow's book which invite criticism are (1) the undue importance ascribed to adrenaline and to the nervous system in the production of wound shock—we find no reference to the toxæmic aspect, which would seem to be more appropriate to the subject matter; and (2) the reference to the liver as "the seat of carbohydrate metabolism in the body," in connexion with diabetes. The views of Langfeld are quoted, but the reversibility of the action of the liver enzymes is not taken into consideration. It seems to the reviewer that this word "metabolism" is used far too frequently in a loose way and often when other expressions would convey the meaning much better. The "metabolism" of carbohydrates, for example, should refer to the complete series of chemical changes which take place from the time of their introduction to their final elimination as carbon dioxide and water. When measurements of the oxygen intake are made, what is really done is to determine the whole oxidative processes and should be called "oxidation," not "metabolism" as is common. Similarly, valuable measurements of output of heat have been made. It would be more useful to speak of such determinations as of heat production, not as of metabolism. One also hears sometimes of mere nitrogen estimations in urine as "metabolism experiments." However this may be, it is certainly misleading to suggest that the liver is the most important place of chemical changes in carbohydrates. The whole problem of diabetes is still in a very unsatisfactory state. May it not be that we have given our attention too much to changes in particular compounds, such as glucose or fat, while the fundamental defect is a general failure in oxidative capacity? Thus the pancreatic hormone might be an oxidation-promoter, possibly for glucose, since there is evidence that the combustion of fat and protein is inadequate except in the presence of and as part of a kind of coupled reaction with that of sugar. "Acidosis" rather than "ketosis" should not now be regarded as the cause of diabetic intoxication, as Prof. Vincent suggests.

The multitude of the physiological phenomena concerned, as well as their practical importance, may serve as some excuse for the length of this review. We may conclude with a list of those organs or tissues which appear to Prof. Vincent to have established their claim to be regarded as producing true hormones. These are the thyroid, pancreas, reproductive organs, adrenals, pituitary body, and the intestinal mucous membrane ("secretin"). The evidence as to the parathyroids (which seem to act otherwise), the thymus, kidney, and pineal body is conflicting. It is to be remembered that the chemical nature of two only of the hormones has been discovered. Even active extracts have not been prepared in all cases. Still more uncertainty exists as to the way in which hormones act. There is much yet to be discovered.

W. M. BAYLISS.

The Origin of Worlds.

Origine et Formation des Mondes. Par l'Abbé Th. Moreux. Pp. xii+401. (Paris: Gaston Doin, 1922.) n.p.

THE Abbé Moreux has essayed, in the volume under notice, the ambitious task of giving a complete explanation of the origin of all the orbs in the solar system. Works on cosmogony have this advantage that no one can positively assert that any particular system is wrong, since certainty is quite unattainable. Hence a reviewer is not called upon to pronounce a theory of cosmogony right or wrong, but merely to note how far it appears to fit in with known facts.

The author uses as his materials nebulæ and meteoric swarms; he attributes the dark lanes in the Milky Way and regions where stars are unusually sparse to meteoric clouds, and supposes the outbursts of Novæ afford examples of the collisions between nebulæ and meteoric clouds which he assumes to be the origin of systems. He uses the spiral nebula analogy in tracing the distribution of the matter scattered by the collision. At this point he notes the fact that the planetary orbit-planes are arranged alternately on opposite sides of the plane of maximum areas. He also conjectures that the two arms of the spiral were in slightly different planes, and that the planets were developed alternately from one or other of them. This idea seems somewhat fanciful; it is fairly obvious that the two most massive planets, Jupiter and Saturn, would have their orbit planes on opposite sides of that of maximum areas, while the same would probably hold for Uranus and Neptune. Another criticism is that his theory, like that of Laplace, makes Neptune much the oldest planet. It was pointed out by the late Prof. Lowell that

apparently the two outer planets were not much further advanced in development than Jupiter and Saturn, although their much smaller size would imply a shorter career and more rapid development; it therefore seems probable that the order of formation of the giant planets has been from the inside outwards, and not the reverse.

In the matter of the origin of the moon the author does not favour the idea of its separation from the earth by fission, holding that it grew from meteors captured in the outer portion of the extended nebulosity which represented the future earth. Throughout the book he postulates the action of resisting medium; many systems of cosmogony do the same.

A few errata may be noted. On p. 207 the author pours scorn on the suggestion that the comets of Tuttle and De Vico have any connexion with the planets Saturn and Neptune respectively; he overlooks the fact that while the inclinations of their orbits are 55° and 85° respectively, the inclinations of their major axes are much less, so that in each case a shift of the node by a few degrees would bring about intersection with the planetary orbit. In the tables of planetary elements he adopts for Venus the very doubtful rotation period of 68 hours, while he treats both the rotation time and the position of the axis of Uranus as unknown, whereas both are known within narrow limits.

It is of course unreasonable to expect a book on such a subject to settle definitely all the matters on which it treats. Viewing it as a setting forth of the problems presented by our system, with more or less plausible solutions, it makes interesting reading.

A. C. D. CROMMELIN.

Reservoir and Other Dams.

The Design and Construction of Dams: including Masonry, Earth, Rock-fill, Timber, and Steel Structures, also the Principal Types of Movable Dams. By E. Wegmann. Seventh edition, revised and enlarged. Pp. xvii+555+plates A-Z+plates AA-VV+plates I-III. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1922.) 50*s*. net.

MR. WEGMANN'S treatise has been before the public for so long that we imagine its general features will be more or less familiar to all who are engaged in the domain of waterworks engineering. The modest volume of 106 pages which appeared thirty-four years ago has, however, developed considerably in the course of time. It is now a ponderous tome of some 600 quarto pages of text, with well over 100 full-page plates in addition. A volume of such weighty proportions cannot fail to impress the reader in point of size alone, and it undoubtedly represents a considerable amount of patient toil in its compilation. It is, in fact, not merely a text-book; it is a work of reference, containing diagrams and particulars of most of the notable dams which have been constructed in recent years. It is permissible to the critic to question the wisdom of combining the two objects in a single volume. To the student, a text-book of modest proportions is a desideratum; he needs something easy to handle and conveniently portable, in the pocket if need be. The work of reference, on the other hand, is only required on occasion and may rest in the bookcase for long intervals. This combination of textbook with an exhaustive, or nearly exhaustive, record of existing examples is open to the objection that it meets the convenience neither of the student nor of the expert. However, we do not wish unduly to press the point.

In the seventh edition Mr. Wegmann has made his treatise replete with information of a highly valuable character. He has included a full description of the Kensico dam, New York; particulars of the movable dams of the New York State Barge Canal; and a brief notice of the Camarasa dam in Spain. This last is stated to be the highest gravity dam in the world, but surely the Arrowrock dam is higher by 20 ft. Probably what is meant is that the depth of water against the Camarasa dam is not equalled elsewhere. Why is the Arrowrock dam not included in the table of high masonry dams? Another very high dam omitted is the Hetch-Hetchy dam. There is, perhaps, some excuse for this omission, as the dam is yet under construction. Still, its dimensions are known and it is an important undertaking. A new chapter on crest gates and siphon spillways has been added, with particulars of examples built both in America and elsewhere, some of them of considerable size.

The subject of dams, of course, is wider than the sphere of waterworks engineering, although this is, perhaps, the most important field of its application. Mr. Wegmann's treatise covers dams as adapted to river engineering operations, and cofferdams as used in foundation work. Briefly, the volume consists of four parts, the first of which deals with the design and construction of masonry dams; the second, with earthen, rock-fill, timber, and steel dams; the third, with movable dams, cofferdams, and overflow weirs; and the fourth with recent dams of all classes. There is an appendix containing the specifications for the New Croton dam with various supplementary notes, a lengthy bibliography which, unfortunately, is not alphabetically arranged (the writer traced some works with difficulty, and failed to find mention of Mr. Powell Davis's book on irrigation works, which contains a

good deal of information on dams), and a fairly full index.

Taken as a whole, the work undoubtedly maintains its high reputation as a standard authority on the subject of reservoir dam construction, and its wealth of diagrammatic profiles from existing examples will cause it to be of great value to the practising engineer, as well as to the student who is seeking to acquire a knowledge of first principles.

BRYSSON CUNNINGHAM.

Science and Progress.

Progress and Science: Essays in Criticism. By Robert Shafer. Pp. xii+243. (New Haven: Yale University Press; London: Oxford University Press, 1922.) 12*s.* net.

THIS volume is almost entirely critical, mainly of the doctrine that science has contributed to a more rapid "progress" of the human race as a whole, and that we may expect this progress to continue. Much of the criticism is acute and many other writers are cited—Prof. Bury, Mr. G. D. H. Cole, Mr. Tawney, and Miss Follett; but the main attack falls upon Mr. F. S. Marvin, whose books, "The Living Past" and "The Century of Hope," are largely quoted in the initial chapter, which gives its title to the whole; he is dismissed in the concluding sentence thus: "It follows that men such as Mr. Marvin are hardly doing us any good, are promoting rather beliefs and hopes which may in the end work an intolerable mischief in the world."

It is a challenge to optimism, or rather to meliorism, based on science, and would have more justification if the author could find any passage either in Mr. Marvin's writings, or in any sympathiser's, indicating a belief either that this progress was complete, or that it could be expected to continue without the strenuous efforts of mankind to carry it further and remedy its defects. This Mr. Shafer does not attempt to do. We are, therefore, reduced to asking him one or two quite simple and direct questions as to his judgment of facts.

1. Is it not a fact that the advance of science in the last three or four centuries has, on the whole, led to an enormous alleviation of human suffering and an increase in the capacity and the facilities for happiness?

2. Has not this advance been accompanied by a growth in the collective consciousness of mankind, quite unparalleled in history? And is not this growth in the sense of "humanity" due, partly to the knitting up of the world by the mechanical application of science, partly to the fact that science is in itself a social thing and that its growth involves the co-operation of multitudes of minds bent on the whole—poison gas and weapons of war notwithstanding—towards increasing human welfare?

3. If this is so, is it an evil or mischievous thing to try to realise these forces in the world and to feel that they are with us in our individual efforts to promote the same great ends?

It should be noticed that Mr. Shafer in his criticism of Mr. Marvin quotes exclusively from the two books mentioned above, which are rather popular summaries of great epochs of history, and does not refer to the more philosophic treatment of the same topics in the various volumes of the "Unity" series published by the Oxford University Press.

Our Bookshelf.

The Union of South Africa. Department of Mines and Industries. The Geology of the Country around Heidelberg; Geological Map of the Country around Heidelberg. By Dr. A. W. Rogers. Pp. 84. (Pretoria: The Government Printing and Stationery Office.) 8*s.* 6*d.* net, including map.

THE publication of the official description of the geology of the Heidelberg district has been anticipated with much interest by South African geologists. The main features of the area have long been known on account of the economic importance of the Nigel Reef. Mainly owing to the pioneer work of Dr. Hatch, it was recognised more than twenty years ago that the Heidelberg district forms the south-eastern limb of the great pitching syncline, on the northern limb of which lies the Rand, and it may at once be said that the result of the detailed survey fully confirms the accuracy of Dr. Hatch's general conclusions. The gradual extension of mining towards the East Rand and the sinking of many bore-holes, some of great depth, have clearly shown that the Nigel Reef belongs to the Main Reef series of the Witwatersrand; it is also shown that the whole Witwatersrand system decreases regularly in thickness towards the south and east, from about 25,000 feet near Johannesburg to 15,000 feet at Heidelberg. This is quite in consonance with the theory of its formation as the delta of rivers coming from an old land to the north-west.

In this memoir the structure of the district is lucidly described. The most remarkable feature is the great Sugarbush fault, so called from its relation to the Zuikerboschrand. This is a new discovery of great importance. The fault is apparently nearly vertical, with a down-throw to the south; at one point in its course, where it brings the Ventersdorp Amygdaloid against the Hospital Hill Series, the throw must be at least 16,000 feet. It therefore ranks as one of the world's greatest dislocations. The fault is certainly of pre-Karroo date, but its relation to the Pretoria Series has not been made out. Probably, however, it was later in date than the deposition of the whole of the Transvaal system, and therefore possibly of early or middle Palæozoic age.

R. H. RASTALL.

Patents for Inventions. By J. Ewart Walker and R. Bruce Foster. Pp. xiii+377. (London: Sir I. Pitman and Sons, Ltd., 1922.) 21*s.* net.

THE authors of this book depart somewhat from the usual manner of treating the subject of patent law. After a brief introductory survey, they first deal with the manner of obtaining a patent, detailing the procedure in the Patent Office and in possible opposition proceedings. Their next concern is the establishment in the courts of the validity of the patent, consideration being given both to the general rules governing the interpretation of patents and to the grounds upon which the patent may be held invalid. Finally, the privileges and responsibilities associated with the possession of a valid patent are discussed, the chapters relating to this covering very fully the rights of the patentee in respect of infringements, royalties, licences, etc., and his liabilities as regards revocation and compulsory licences.

By presenting the subject in this sequence, the principles underlying patent law are linked up in a manner which can easily be followed. As, in addition, the treatment throughout is clear and concise and avoids undue stress upon legal technicalities, the book should commend itself not only to legal practitioners but also to business men, directors of industrial research, and others who are interested in the protection and commercial exploitation of inventions.

An appendix, which extends to a little over half the book, contains as its most valuable features the Patents and Designs Acts in a consolidated form, and a list of the leading cases to which reference has been made in the text. Of lesser value relatively are the reprints of the patents forms, the Patents Rules, and the war legislation, the inclusion of which accounts for the abnormal size of the appendix. These reprints, we think, might very reasonably have been dispensed with as adding unnecessarily to the cost of a very useful book. E. J.

Technische Träume. Von Hanns Günther (W. de Haas). Pp. 83. (Zurich: Rascher & Cie, 1922.) 50 marks.

THIS illustrated pamphlet issued free to subscribers to the journal *Natur und Technik* contains short accounts of the most important of the proposals which have been made from time to time either to use coal more efficiently in view of its complete exhaustion 1500 years hence, or to substitute for it some other source of power. Of schemes falling within the former category the author thinks Ramsay's plan for converting coal into water-gas *in situ* not likely to prove successful, and attaches more importance to the proposals to generate electric current thermo-electrically or by means of carbon cells. Apart from coal and petroleum, natural power has been derived from sunlight, from the wind, from steam in volcanic regions, from the tides, and from the waves of the sea. Sunlight power plants in tropical regions can, he considers, compete with coal at 10*s.* a ton, while at Landerello in Tuscany all domestic and power heating is supplied by steam from underground heat. The waves have not proved an economical source of power, but the tides are more promising where the necessary structural work is not too costly. The estimated costs of the Severn Scheme the author thinks too low.

Filtration: An Elementary Treatise on Industrial Methods and Equipment for the Filtration of Liquids and Gases for those Concerned with Water Supply, Ventilation, and Public Health; Chemists, Mechanical Engineers, and Others. By T. Roland Wollaston. (Pitman's Technical Primers.) Pp. x+102. (London: Sir I. Pitman and Sons, Ltd., 1922.) 2*s.* 6*d.* net.

THE very ambitious title of this small volume would naturally lead one to expect more than is contained in the book. The author has wasted a good deal of the space at his disposal by a rambling style and by irrelevant discussions. Thus, on p. 4 no less than thirteen lines are sacrificed to a reference to a paper in connexion with two very simple chemical equations which are to be found in every text-book. Much of the text deals with very elementary matters, which should be assumed to be known by the readers. In consequence, the remaining space is insufficient to render possible a clear description, in sufficient detail, of apparatus for technical filtration.

The Tutorial Chemistry. Part 2, *Metals and Physical Chemistry.* By Dr. G. H. Bailey. Edited by Dr. W. Briggs. 12th impression (4th edition). Pp. viii+494. (London: University Tutorial Press, Ltd., 1922.) 6*s.* 6*d.*

DR. BAILEY'S text-book, in its revised form, will continue to be useful to students. It gives a clear introductory course of physical chemistry and of the chemistry of the metals. A good feature is the inclusion of brief accounts of the so-called "rare metals," many of which are now technically important. Specific heats at low temperatures might have been mentioned, and we also miss any allusion to Werner's theory and the cyanide process for silver extraction. There are some criticisms which might be made. The definitions in connexion with the phase rule (§ 45) are not sufficiently precise. Stas's silver was not so pure as is implied (§ 281); the existence of MnO_3 is doubtful; stannous oxide is olive coloured, not black; and the atomic weight of nitrogen is not a whole number within the limits of experimental error (§ 508).

Mentally Deficient Children: Their Treatment and Training. By Dr. G. E. Shuttleworth and Dr. W. A. Potts. Fifth edition. Pp. xviii+320. (London: H. K. Lewis and Co., Ltd., 1922.) 10*s.* 6*d.* net.

THE fact that a fifth edition of this book has been required is sufficient evidence of its value. It gives in a very comprehensive form a quantity of useful information, legal and medical, concerning the mentally defective child. At the beginning of the book there is an interesting account of the early efforts of Séguin and other pioneers in this field. This is followed by chapters on the regulations in England and other countries, the types of mental defect, the treatment available, educational, industrial, and moral training. The appendices supply a list of institutions, both in England and America, where treatment is given, as well as the medical certificate forms under the Mental Deficiency Act, and a list of the Binet-Simon tests. There is also an excellent bibliography.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Isotopes of Selenium and some other Elements.

THE first experiments with selenium some time ago were not successful. Very satisfactory mass-spectra have now been obtained by vaporising the element itself in the discharge tube. The interpretation of these is quite simple and definite, so that the results may be stated with every confidence. Selenium consists of six isotopes, giving lines at 74 (*f*), 76 (*c*), 77 (*e*), 78 (*b*), 80 (*a*), 82 (*d*). The line at 74 is extremely faint. The intensities of the lines are in the order indicated by the letters, and agree well enough with the chemical atomic weight 79·2. Measurement of the lines shows no detectable deviation from the whole number rule.

Application of the method to cadmium and tellurium has failed to give the mass lines of these elements. The employment of the more volatile $TeCl_4$ was also unsuccessful, but incidentally gave evidence of great value, which practically confirms two facts previously suspected, namely, that chlorine has no isotope of mass 39, and that aluminium is a simple element 27.

During some work requiring very prolonged exposures with a gas containing xenon, two new isotopes of that element were discovered at 124, 126, making nine in all. The extreme faintness of both lines indicates that the proportion of these light isotopes in the element is minute.

It will be noticed that the first of these is isobaric with tin, and that the seleniums 78, 80, 82 are isobares of krypton. All isobares so far discovered, including the radioactive ones, have *even* atomic weights.

F. W. ASTON.
Cavendish Laboratory, Cambridge, November 6.

Bohr's Model of the Hydrogen Molecules and their Magnetic Susceptibility.

BOHR'S model of the molecules of hydrogen explains very satisfactorily the light dispersion of hydrogen,[1] and gives the same value for the moment of inertia as that deduced from the specific heat;[2] but it is generally believed that the model does not explain the diamagnetic property of the gas.[3] For, according to P. Langevin's theory,[4] the hydrogen molecules must have paramagnetic susceptibility, while as a matter of fact the gas is diamagnetic, as determined by Dr. T. Soné.[5] But, as this note will show, this conclusion is not correct.

It is well known that, besides three degrees of freedom for translation, hydrogen molecules possess two degrees of rotational freedom. According to Bohr's model, this rotational motion must, from the point of view of symmetry, take place about an axis perpendicular to the magnetic axis of the molecules—that is, an axis perpendicular to the line joining two positive nuclei. This rotational motion is uniform and increases with the rise of temperature. Hence the magnetic effect of each molecule due to the revolving electrons vanishes on account of the rotational motion. In this case, therefore, Langevin's theory of paramagnetism is not applicable. Obviously his theory can be applied only when the gas molecules have no degree of rotational freedom, or when they revolve only about their magnetic axes.

If a strong field acts on a uniformly revolving magnet in its plane of revolution (Fig. 1), the rotation begins to become slightly accelerated in the half-revolution in the direction of the field and retarded in the other half, this causing a diamagnetic effect.[6] In the case of the molecules of hydrogen the moment of inertia about the axis of rotation is, however, very large on account of the positive nuclei being apart from each other; hence, during rotation, these two revolving nuclei behave like a large flywheel, and before the revolution of the molecules is sensibly accelerated it is newly excited by thermal impacts. Hence we may assume that this rotation is not sensibly affected by the action of a strong magnetic field, and therefore, in the mean, remains uniform throughout. The hydrogen gas is then diamagnetic, and its susceptibility can be calculated by Langevin's theory of diamagnetism.[7]

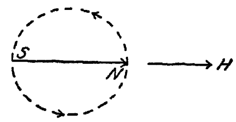

FIG. 1.

Assuming Bohr's new model of the hydrogen molecules (in which the electrons have elliptic orbits), we have for the major axis of the orbit

$$a = \frac{h^2}{4\pi^2 m e^2 \left\{ \frac{2}{(1+\kappa^2)^{\frac{3}{2}}} - \frac{1}{4} \right\}} (n+n')^2,$$

$$\kappa = \frac{1}{\sqrt{3}}, \qquad 1 - \epsilon^2 = \frac{n^2}{(n+n')^2},$$

where h is Planck's universal constant, m the mass of the electrons, and e their charge; ϵ is the eccentricity of the orbit, n and n' are the azimuth and radial quantum numbers.

In the case of $n+n'=1$, the possible orbit is $n=1$, $n'=0$, which reduces to a circle, the radius of which is

$$a = 0{\cdot}507 \times 10^{-8},$$

$$\frac{h^2}{4\pi^2 m e^2} \text{ being } 0{\cdot}532 \times 10^{-8}.$$

The magnetic susceptibility of the gas per gram-molecule is given by

$$\chi = -\frac{nm}{12}\left(\frac{e}{m}\right)^2 \Sigma a^2,$$

where n is the total number of electrons and Σ is to be taken for different orbits. Applying this formula to the above case, we have

$$\chi = -0{\cdot}712 \times 10^{-6}.$$

In the case where $n+n'=2$, $n=n'=1$ corresponds to the elliptic orbit. Here $\epsilon^2 = 3/4$, and the equivalent radius of the circle is

$$a = 1{\cdot}433 \times 10^{-8} \text{ cm.},$$
$$\chi = -5{\cdot}70 \times 10^{-6}.$$

The diamagnetic susceptibility $\chi = 3{\cdot}96 \times 10^{-6}$ observed by Dr. T. Soné lies between these two. In actual cases a certain fraction of the whole number of molecules may have the first orbit ($n=1$, $n'=0$), and the other fraction the second orbit ($n=n'=1$), etc. As the orbit becomes greater there is a greater chance that it will collapse into a smaller orbit;

[1] Debye, Münchener Akademie (1915), 1.
[2] Reiche, *Ann. der Phys.*, **58** (1919), 682.
[3] J. Kunz, *Phys. Rev.*, **12** (1918), 59.
[4] P. Langevin, *Ann. de Chem. et de Phys.*, **8** (1905), 70.
[5] Sci. Rep. **8** (1919), 115.
[6] K. Honda and J. Okubo, Sci. Rep. **5** (1916), 325.
[7] P. Langevin, *l.c.*

hence the number of molecules with an orbit (n, n') at any instant rapidly decreases with the increase of n and n'. If we assume that the hydrogen gas contains only the first and second kinds of molecules, viz., 35 and 65 per cent. respectively, then the calculated value exactly coincides with that observed.

KÔTARÔ HONDA.
Research Institute for Iron, Steel, and other Metals,
Imperial University, Sendai, Japan,
September 22.

Gravity Observations in India.

THE importance of the bearing of a change in the force of gravity, if such could be established, on all problems connected with the physics of the earth, especially those of the origin of mountains, continents, and oceans, is sufficient justification for directing attention to certain peculiarities in the determinations which have been made at Dehra Dun.

When observations of gravity in India were resumed in 1904, with a group of four identical half-seconds pendulums of v. Sterneck's pattern, the value of gravity at Dehra Dun was determined, by comparison with Potsdam, as 979·063 dynes. The earlier observations of Basevi had given a value equivalent to 978·962 dynes, so there was an apparent increase of 0·101 dyne in the interval between the two sets of observations.

A fuller examination of the evidence has shown that no such conclusion can be drawn from the comparison of these two sets of observations. Basevi's final value at Dehra Dun was derived from an elaborate series of observations, made in a room specially adapted for experimenting on the effect of changes of temperature, and in this the legs of the stand were supported on brick pillars. At the time it was unknown and unsuspected that this would seriously vitiate the results, and we have also on record the value obtained from a preliminary observation, conducted under conditions similar to those in his other stations, where the stand rested directly on a concrete floor at ground-level; this preliminary observation gave a value discordant from the final ones, but differing from the 1904 value by about the same amount as is found in other of his stations which have been re-observed. The position was, therefore, that there was no proof of any change of the force of gravity at Dehra Dun, but equally there was no disproof of such change having taken place; all that could be said was that, if any change had taken place, it must have been of a much smaller order of magnitude than one-tenth of a dyne.

In the course of the new series of observations further evidence came to light. The pendulums, swung regularly every year at the commencement and close of each field season, showed a gradual decrease in the period of vibration till, in November 1909, the mean period had decreased by 0·0000043 seconds, making the apparent value of gravity 979·079 dynes. Since then the time of vibration showed a gradual increase till in April 1913 it had reached a value only 0·0000012 seconds less than in 1904. It has been suggested[1] that the increase after 1909 was due to a gradual wearing of the agate edges; the suggestion is a possible one, but it leaves unexplained the diminution between 1904 and 1909, which was evidently due to some cause which affected all four of the pendulums in about equal degree. There was no change in the routine of observation[2] which could account for it, and the alternatives seem to be a gradual molecular change in the material of the pendulums, leading to change in length, or a real change in the value of the force of gravity at Dehra Dun. As all four pendulums were made at the same time, of the same material, and, so far as possible, of the same form and dimensions, the former is not impossible, but the latter would equally affect all four simultaneously and alike. The situation therefore remained as in 1904, that, so far as the Indian observations are concerned, there was neither proof nor disproof of any change in the force of gravity having taken place.

In addition to the observations of the Survey of India there have been some other determinations of gravity in India. In 1905 Hecker, at Jalpaiguri, obtained a value which was 0·002 dyne in excess, and in 1906 Alessio, at Colaba, a value of 0·004 dyne in defect, of the Survey of India values, being in substantial agreement with the value determined at Dehra Dun in January-February 1904. In 1913 another determination was made at Dehra Dun, by Prof. Alessio, with an apparatus consisting of eight pendulums prepared for the Filippi expedition to Central Asia, and the value obtained, which has only recently been announced,[3] was 979·079 dynes, or 0·016 dyne in excess of the standard accepted value used by the Survey of India, as determined in 1904. The position therefore now is that, while independent direct comparisons made in the two years following the commencement of the new series of observations in India showed substantial agreement, a similar determination made nine years later showed a material difference, and this opens out the possibility that part, at least, of the changes noticed at Dehra Dun may have been due to a real change in the force of gravity at that place.

The difficulty of accepting such interpretation is less at Dehra Dun than at many other stations, for that place lies on the fringe of the Himalayas, the elevation of which has been one of the latest incidents in the geological history of the earth, and it also lies in a region where the surface deformation, established after the earthquake of April 4, 1905, shows that changes are still taking place.

It is to be hoped that when gravity observations are resumed in India the matter will be looked into; in part the doubt left by these observations might be cleared up by the re-observation of some of the Peninsular stations, where gravity was determined at the outset of the series and about 1909. For example, Colaba (1904), Mysore (1908), and Jubbulpore (1910) seem convenient and suitable; a fresh determination at these stations would show whether there had been a change in the force of gravity as compared with the reference station of Dehra Dun.

R. D. OLDHAM.

[1] H. J. Couchman, Prof. Pap., Survey of India, No. 15, p. 2.
[2] Records, Survey of India, vol. 2, 1913, p. 33.
[3] *Rivista Marittima*, March 1922, Supplement, p. 73.

The Miraculous Draught of Fishes.

To the several names of the Sea of Galilee, Prof. Gudger, in his very interesting letter (NATURE, October 28, p. 572) has thrice added "Lake of Tiberius," evidently by mistake for "Lake of Tiberias." Also he omits any reference to the important paper by Prof. Théod. Barrois, "Contr. à l'étude de quelques lacs de Syrie" (in *Rev. Biol. du Nord de la France*, tome vi., 1894), which usefully summarises what is known of the fauna of the lake in modern times from Belon in 1553 to his own date in 1894. The lake, it appears, contains twenty-two species of fish, some small fishes and some large ones in vast abundance. As of old, it is subject to sudden squalls, dangerous to navigation. Some of its inflowing waters for their

healing properties have, says Prof. Barrois, from the most remote antiquity, attracted patients suffering from eczema, arthritis of every kind, and other afflictions. But, with regard to Prof. Gudger's ingenious explanation of the miraculous draught of fishes, coupled with Lortet's description of the behaviour of grebes over a shoal of large Chromids and Canon Tristram's account of their dorsal fins as seen at the surface, surely the wonder is that experienced fishermen like St. Peter should have needed outside assistance, let alone superhuman aid, as is implied in the narrative of St. John's Gospel.

T. R. R. S.

Tunbridge Wells, October 30.

IN the passage from Lortet's work on the Lake of Tiberias, quoted in Prof. Gudger's interesting letter in NATURE of October 28, p. 572, the scientific title of the crested grebe is given as *Podiceps cristatus*. This misrendering of the true name of the genus Podicipes may be traced, I think, to Yarrell, for it appears in his "History of British Birds," published in 1845. Yarrell was not a classical scholar; but it is strange that the late Lord Lilford should have slipped into the same error in his splendid "Coloured Figures of British Birds." The difference in form is important, because Podiceps, if it means anything, means "rump-headed"; whereas in coining the word Podicipes, meaning "rump-footed," Linnæus indicated the posterior position of the feet so characteristic of the genus.

HERBERT MAXWELL.

Monreith, Whauphill,
Wigtownshire.

PROF. E. W. GUDGER's letter on this subject in NATURE of October 28, p. 573, is interesting from the natural history point of view, but it misses the most suggestive point in the narrative. That point is the number—one hundred and fifty and three. What is the meaning of this very definite figure? It will scarcely be contended that the number is merely the simple statement of a historic fact—that the fishes caught did actually number one hundred and fifty and three, neither more nor less! The naïve literalism of such an explanation is totally blind to the true significance of the story.

Obviously, the story is a parable. The lake of Gennesaret is the world. The fishes are the souls of men. The net that is not broken is the Church. And the number? That is a problem, but an explanation I heard given in a sermon by my father, the late Rev. R. B. Drummond, of Edinburgh, seems to meet the case. Where he found the solution I do not know. It was not original.

The Jews, as is well known, attached a mysterious significance to numbers, and if they met a definite number like this, they would not pass it by unheeding, but would try to discover its meaning. Well now, this number is what is called the perfection of the number 17; that is to say, it is the number arrived at by adding all the consecutive numbers from 1 to 17 inclusive. And the number 17 itself is the sum of the two sacred numbers 7 and 10. These again (here I am a little vague as to why) stand respectively for the Jews and the Gentiles. Hence the story means that the net of the Church is able, without breaking, to gather together not only, as some contended, Jews and those who became Jews, but all sorts and conditions of men of every race and tribe.

W. B. DRUMMOND.

Baldovan Institution, by Dundee.
November 1.

PROF. GUDGER's communication under this heading in NATURE for October 28, p. 572, has brought back to me a vivid recollection of a fishing incident in the north-west of Ireland. About a dozen years ago I spent a week-end at Ballina, County Mayo, and as the express to Dublin did not leave until after mid-day, I devoted Monday forenoon to a ramble along the banks of the Moy river. Observing several men, with a boat and draw-net, making a succession of fruitless attempts to land fish, I crossed the river and made my way to them. It was true—they had toiled and had caught nothing. They were putting out to make another attempt, and I offered them five shillings for the next haul. They declined. The net was hauled in, and there was not a scrap of anything in it. They put off again, and I repeated my offer, which was rejected, and the net came in empty, as before. With all their futile endeavours the men were not in the least put out. Calmly the boat and net were again got ready, and I was told it would be no use offering to buy the haul. When the net was landed it was found to have brought in one little fish—a sprat in size! Apparently this was looked upon as a good sign—a command to try again, for, still undaunted, the men persevered—they rowed off cheerfully, let out the net, then returned to shore and hauled at the net, but evidently it was harder work than on any previous occasion. When the operation was completed, hundreds—the men said eleven hundred—salmon had been landed! A school from the sea had come up on the rising tide.

HY. HARRIES.

October 28.

On the Reality of Nerve Energy.

I HAVE only to-day seen Dr. Adrian's letter of September 30 in which he states with great clearness the present-day physical explanation of the nature and transmission of the nerve impulse.

It seems to me that it is the relation of this nerve impulse to nerve energy that stands in need of elucidation. My present concern is not so much to recommend the more extensive use of the term nerve energy as to make sure that when physiological or medical writers use it, we shall have some more accurate notion of what they mean by it. Evidently, from what Dr. Adrian says, sometimes they mean mental energy. Surely mental energy is not what is meant in the following paragraph, "In defæcation, when all the nerve energy of the cord is directed into one channel . . ." (Verdon, "Angina Pectoris," Brighton, 1920, p. 357). The late Sir William Osler wrote: "An organisation which is defective in what, for want of a better term, we must call nerve force . . ." ("Principles of Medicine," 1895, p. 1032).

Prof. Halliburton, in reviewing von Monakow's "Die Lokalisation im Grosshirn" (*Physiol Abst.*, Nov. and Dec. 1918), thus expressed himself, "The introduction of a change in the quantity of nervous energy (Hughling's Jackson) passing over a given system of Conduction paths . . ." In his "Text-book of Physiology" (London, Churchill, 1912, p. 1211), Prof. Starling wrote: "During the second stage (of asphyxia) there is a discharge of nerve energy which spreads throughout the whole central nervous system, beginning in the Bulbar Centres . . ." In none of these quotations is it a synonym for mental energy, unless, perhaps, we except Osler's use of it.

(To recognise "mental energy" as a real existence in the sense of being a *vera causa* of neural processes is, I believe, necessary, but it involves grave difficulties both in psychology and metaphysics.)

The authors just quoted are surely not indulging

in metaphors; they evidently have something quite definite before them which they believe is conveyed to their readers. Is it what other writers, *e.g.* Sir Frederick Mott, would call innervation? Apparently so, for he writes in "The Brain and the Voice in Speech and Song" (*Harper's*, 1910) of "innervation currents." Now currents must be real, must be a flowing of something.

Clinicians—neurologists—believe in nerve energy, but apparently they do not derive their belief from their physiological teachers, for, according to McDougall, "the professional physiologists refer to it (nerve energy) contemptuously as a survival from the Dark Ages." Without doubt, something here is in need of being cleared up.

The intelligent layman thinks there *is* such a thing as "nerve energy," physicians use the term constantly, some professional physiologists use it when they find it convenient, and yet Dr. Adrian assures us that "as a physiological concept, 'nerve energy' has little to recommend it." If that is so, it is unfortunate the term is so popular. Dr. Adrian, however, concedes that "If the term 'nerve energy' is to be retained, it might be used to mean the total potential energy in the neurone available for use in the transmission of impulses."

This definition is so broad that it would cover (as it should) such cases of innervation as cerebellar control of other nerve centres, as well as unconscious cerebral inhibition of certain lower centres, neither of which could be called mental energy.

This is all that is wanted as a beginning of the clearing of the air. In this sense, nerve energy is real. I had only suggested it might be measured in order, if possible, to satisfy the demand that as a form of energy it should be measured.

It now remains for some physiologist to discuss the reality of nerve energy by defining the concept, relating it to nerve impulses and to innervation-processes, and placing the term in his index. Then the neurologist and psychopathologist would know whether he was using the term nerve energy in the same sense as that in which other men of science use it. In time, something more definite than at present would filter through to the laity.

D. FRASER HARRIS.

Dalhousie University, Halifax, N.S.,
October 11.

Habits of *Echinus esculentus*.

IN the October issue of the Journal of the Marine Biological Association, Miss Trewavas records the occurrence of *Echinus esculentus* between tide-marks on the Cornish coast and makes a request for information "of the occurrence or absence of this sea-urchin between tide-marks at other parts of the British coast."

In this district *E. esculentus* occurs abundantly between tide-marks in spring and early summer, on rocky coasts; a few may be found at almost any other season. About February or early March a shoreward migration seems to set in, so that in suitable weather conditions some hundreds may be collected at springs between April and June. Then their abundance decreases until about November, from when until January it is at a minimum. This inshore vernal maximum is coincident with the spawning season; ripe individuals being found from February to August with a maximum occurring in early May. A similar shoreward spawning migration occurs in other, chiefly Boreal, species—*Solaster papposus, S. endeca, Henricia sanguinolenta, Archidoris tuberculata, Jorunna Johnstoni, Aeolidia papillosa, Leander squilla, Spirontocaris pusiola,* and doubtless various other species.

The presence of *E. esculentus* between tide-marks is strongly influenced by various conditions—*e.g.* (1) in April 1921 a spell of sharp frosts caused numerous urchins which had invaded the intertidal zone to retire to deeper water, where they were visible in abundance in 1-2 fms.; (2) during the hot spell of May and June 1921 they were unusually scarce between tide-marks; (3) in April 1922 a spell of heavy weather either washed away or caused a temporary seaward movement of urchins from the intertidal area, and further, although they had also been abundant in 1-2 fms., none were to be seen there, all having apparently retired into the shelter of crevices and boulders. There is some evidence that males approach the shore ahead of the females. While inshore, urchins feed very largely on barnacles.

On an average the life of *E. esculentus*, as an urchin, begins about midsummer: the first months are spent in the Laminarian zone browsing freely on such limy food as Membranipora; by the end of the calendar year some are well over 2 cms. in diameter and at the close of their I.-year period about 4 cms., the more advanced having spawned about May at an approximate age of 10-12 months. The II.-year group appear to range between 4-7 cms., the III.-year group 7-9 cms., and the IV.-year group 9-11 cms. Largely owing to the prolonged spawning period there is no discontinuity between the year groups, which merge into one another. The adults feed on Polyzoa, Laminaria—particularly if encrusted with Membranipora,—balanids, etc. In October urchins are found with large gonads rich in fats; an occasional one may have a few immature ova. The yearly cycle would seem to be:

July–November—Growth and fattening of gonads—Laminarian zone offshore.

December–March—Maturation of gonads—Laminarian zone offshore.

April–June—Spawning—largely inshore.

RICHARD ELMHIRST.

Marine Biological Station,
Millport.

Perseid Meteors in July 1592.

MAY I bring it briefly to the notice of readers of NATURE that there is apparently a reference in the history of Akbar, the Emperor of India, to a brilliant display of Perseid meteors in the Panjab about the end of July 1592. The passage occurs in the account of the 37th year of the reign, and just before the description of Akbar's expedition to Cashmere.

Akbar and his son Daniel had left Lahore and crossed the Rāvī, and were encamped at a garden called the Rāmbārī. On the 27th day of Tīr O.S., which might correspond to about July 28, 1592, three hundred little stars or pieces of stars (*sitāracha*) were seen traversing the heavens from west to east. The Persian text does not say whether this was in the day or in the night, but presumably it was the night or at least the evening, for the meteors would not be visible during the day.

Akbar and his son were so alarmed at this appearance, which took place three days after their departure from Lahore, and while they were still encamped at Rāmbārī, that they at once consulted the astrologers who were with them in the camp and by their advice broke up their camp and returned to Lahore. Nor did they resume their march till about a fortnight later and after they had ascertained a more auspicious day for a start.

Perhaps the phenomenon was not seen in England or even in Europe. The night may have been foggy, or the transit of the meteors may have taken place in the daytime there.

It does not seem impossible that Shakespeare may have heard of the display from sailors and other travellers in the east when he wrote about the close of the sixteenth century of certain stars shooting madly from their spheres. H. BEVERIDGE.

53 Campden House Road, W.8,
October 26.

Skin Effect in Solenoids.

SKIN effect in long, single layer solenoids wound with solid round wire and used at very high frequencies has been treated by Sommerfeld,[1] Lenz,[2] and Abraham, L. Bloch, and E. Bloch.[3] (The frequency is supposed so high that the Rayleigh approximation applies.)

The last of these disagrees with the first, giving the ratio of the resistance of a closely wound solenoid to the resistance of the wire of the solenoid when stretched out straight and used at the same frequency as equal to 3·73, while Abraham, L. Bloch, and E. Bloch obtained 3·46. The writer calculated the same ratio by a different method and obtained $3{\cdot}4 \pm 0{\cdot}02$. Going through the calculation of Sommerfeld and correcting for an error in the graphical evaluation of the area under Sommerfeld's curve, the same result (3·41) is obtained by Sommerfeld's method. For loosely wound solenoids the calculations of Abraham, L. Bloch, and E. Bloch, Lenz, and the writer are in fair agreement.

On reading this letter Prof. Sommerfeld has informed the writer that he agrees with this conclusion.
G. BREIT.

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Colour Vision and Syntony.

AFTER reading the letter of Dr. Edridge Green (NATURE, October 14, p. 513) it occurred to me that the following method, involving no head movement, of observing the movement of positive retinal "after images" might be of interest. If, in a dark room, the eyes being in a state of "dark adaptation" and one covered, a dry petrol lighter of the spring release type be flashed, a fan-shaped pattern of brilliant streamers will be seen. This pattern is followed by a similar "after image." The "after image" immediately begins to contract. This contraction continues till the after image appears as a rather thick irregular line of smaller area and greater brilliancy than the original pattern. The rapidity of the change, and the final form varies for different parts of the retina. Two points are of interest, the contraction of the image, and the increase of brilliancy.
H. S. RYLAND.

London, S.E.,
Oct. 16.

Mosaic Disease in Plants.

THERE has been considerable speculation recently upon the cause of the so-called 'virus diseases," which occur in both animals and plants, such as typhus and Rocky Mountain fever in man, and "mosaic" disease in plants. These diseases are supposed to be due to the presence of some ultra-microscopic filter-passing organism. Many small bodies, some of a granular nature, have been described in connexion with these disorders, such as Rickettsia, Negri bodies, etc. As regards the mosaic disease of plants, L. O. Kunkel, a worker in Hawaii, last year demonstrated the presence of a peculiar body of amœboid appearance in the diseased cells of maize affected with mosaic.

The purpose of this communication is to place on record the discovery of apparently similar bodies in the tissue of potato plants affected with mosaic, a disease which, so far as the potato is concerned, has become of considerable economic importance. No attempt is made at present to define the nature of this body, but it is hoped that further work may throw more light on the subject. All that can be said is that there is invariably present in the cells of mosaic potato tissue, in close association with the nucleus, an abnormal body which is definitely connected with the disease. Preparations showing these bodies were demonstrated at a recent meeting of the Association of Economic Biologists in London.
KENNETH M. SMITH.

The Victoria University of Manchester.

Einstein's Paradox.

IN his review of Bergson's new book (NATURE, October 14) Prof. Wildon Carr refers to "Einstein's paradox," which he quotes in inverted commas as follows:—"Suppose a traveller to be enclosed in a cannon-ball and projected from the earth with a velocity amounting to a twenty-thousandth of the velocity of light; suppose him to meet a star and be returned to earth; he will find when he leaves the cannon-ball that if he has been absent two years, the world in his absence has aged two hundred years." It so happens that a paradox of this identical kind was proposed to Einstein himself by M. Painlevé at the Paris conferences in April of this year. Unless I have greatly misunderstood Einstein's reply, as recorded by M. Nordmann in the *Revue des Deux Mondes* of May 1, this particular paradox, arising from the imaginary departure and return of an observer travelling with great speed from a given point and back again, was shown to be one not legitimately derivable from the restricted theory—the theoretical construction is not one to which the transformation formulæ can properly be applied (pp. 146-152).

The humble student of relativity is therefore in the position of a schoolboy who finds that what he learns from one master to-day is contradicted by another to-morrow. Bergson and Nordmann both speak with Einstein's voice; but whereas the former apparently puts the paradox before us categorically as an inescapable Einsteinian fact, the other represents it as a non-Einsteinian fiction. Which of these two views are we to accept? They cannot both be true. Einstein, as quoted by M. Nordmann, advanced good reasons for putting the paradox out of court; but as Bergson was present at some at least of the conferences it appears that these reasons did not seem to him to be convincing.

There is a certain indefiniteness of phrase about the paradox as quoted above which gives rise to doubt. The only observer mentioned is the traveller in the cannon-ball; and it is quite overlooked that he would naturally expect the difference between his time and earth time to be in exactly the opposite direction—he would expect earth time to have advanced by only one-hundredth of his own time.

[1] A. Sommerfeld, "Über den Wechselstromwiderstand von Spulen," *Ann. d. Phys.*, 329, p. 609, 1907.

[2] W. Lenz, "Über die Kapazität der Spulen und deren Widerstand und Selbstinduktion bei Wechselstrom," *Ann. d. Phys.*, 342, p. 923, 1912.

[3] H. Abraham, L. Bloch et E. Bloch, "Radio-télégraphie militaire," 1919, E.C.M.R. Report No. 4629.

If the traveller happened to be a relativist, his faith in the transformation formulæ would receive a rude shock when, instead of the seven and a half days he had calculated, he found on returning that the earth had aged no less than two hundred years.

There is also an obvious slip as regards the speed necessary to produce so large a difference in computed time (assuming the paradox to stand good). An observer travelling out and back with a velocity of one twenty-thousandth the velocity of light, or 9·3 miles per second, would only expect a difference of *one-twelfth of a second* in either direction between his own time and earth time after two years.[1] This is perhaps fortunate for us, as the earth travels with twice this velocity, or 18·5 miles per second in its orbital course. The cannon-ball would indeed have to be projected with a velocity of *within* one twenty-thousandth of the velocity of light, *i.e.*, $v=c(1-1/20,000)$ or with the incredible speed of about 185,990 miles per second, to produce the result stated.[2]

This, however, which is plainly only a *lapsus calami*, is of small importance. The difficulty is created, not by the magnitude of the paradox, but by its existence, and the contradiction it opposes to common sense. If true, it throws the whole relativity doctrine into the lap of metaphysics, from which, if we are to believe M. Nordmann, Einstein was determined to rescue it. "La théorie d'Einstein est née de problèmes posés par l'*expérience*. Elle est née des faits, et son auteur insiste avec beaucoup de vigueur sur ce point. . . . Elle est tout le contraire d'un système métaphysique" (p. 134, *loc. cit.*). Obviously this paradox, in any of its forms, can never be subjected to the test of experiment; and as it is a fundamental principle with Einstein that nothing must enter into his theory (and therefore that nothing must interfere with his theory) that cannot be so tested, is not the difficulty thereby automatically ruled out of consideration? These are deep waters, into which a sciolist like myself has to venture carefully, even when it is done of necessity, by way of question, in search of information from competent authority.

H. C. Browne.

Dublin, October 26.

There is, as Mr. Browne points out, a *lapsus calami* in my quotation. The supposed velocity of the cannon-ball is, not a twenty-thousandth of, but less by about a twenty-thousandth than, the velocity of light. It is an often-quoted paradox, which I heard for the first time from M. Langevin in his address to the Philosophical Congress of Bologna in 1911, and the discussion of it occupies a large part of M. Bergson's book. With regard to the paradox itself, it is, as Mr. Browne very well points out, not a paradox for the relativist but an illustration of the consequence of rejecting the principle of relativity. In exactly the same way Zeno's paradoxes were not paradoxes for Zeno but arguments for his doctrine that nothing moves. The principle of relativity is that it is possible to pass to a completely different frame of reference without breach of continuity, provided that the space-time coefficients vary to maintain the ratio constant. The paradox shows the form which the breach of continuity will assume if with common-sense we suppose the change of the system of reference not to be compensated by a variation in the space-time co-ordinates. There are, in fact, two alternatives. I may conceive my traveller retaining the dimensions of his old system in his new system, then he will become a kind of ephemeral insect or microbe in his new environment, for his proportions will be incommensurate with his old proportions; or, I may conceive him automatically shrinking or expanding in his dimensions proportionately to the change in his environment, then, however much the system changes, he can never become aware of it. This is what I referred to in my article as the relativity of magnitudes. The paradox disappears in the principle of relativity; it arises because common-sense is accustomed to the view that space and time are constant and invariable.

H. Wildon Carr.

November 1.

[1] Taking $c=1$, and $v=1/20,000$,

$$t=t' \div \sqrt{1-1/400,000,000}=t'(1+1/800,000,000+\text{a negligible})$$

when $t'=2$ years, $t=2$ years $+\frac{63,072,000}{800,000,000}$ seconds, or $t-t'$ is less than 1/12 second.

[2] $c=1$, $v=1-1/20,000$. $1-v^2=\frac{1}{10,000}-$ a negligible, or $\sqrt{1-v^2}=\frac{1}{100}$. Therefore $t=100t'$.

Waterspouts.

Corroborating the letter of Dr. G. D. Hale Carpenter in Nature of September 23, p. 414, reference may be made to a note in *Monthly Weather Review*, 43, p. 550-551, 1915, where a funnel or pendant seen near Cape San Lucas, Lower California, is described and sketched; the sheath or sleeve seen by Dr. Hale Carpenter was very striking. The phenomenon was under observation a considerable time.

Also, the following from my note-book on an observation made in Manila, P.I.:

"*1919 V. 24 d. 6 h. 15 m. P.M.*—Under a thunderstorm developing in N., from my window I saw a small tornado funnel stretching downward in N.W., obliquely toward W. or S.W. It did not reach halfway to earth; the sun was so low that a flood of yellow light poured horizontally under the cloud, and the funnel was brilliantly lighted. The figure and description given in my note, *Monthly Weather Review*, November 1915, apply excellently, except that the brighter illumination brought out the hollow core better. The distance was greater, so that I could not very well make out the lattice pattern."

This one showed the sleeve or sheath very well. Another, mentioned in the same note in the *Monthly Weather Review*, a gauzy but large waterspout, extending clear to the water, and causing there a great powder-puff of spray, did not show the sleeve at all. (This was near San Salvador, in the Bahamas; the position given by latitude and longitude is quite wrong, inserted by some other hand.)

Willard J. Fisher.

Cambridge, Mass., October 16.

Tables of the Incomplete Gamma-Function.

I should be greatly obliged if you could allow me a little of your valuable space to state that Dr. J. F. Tocher has kindly pointed out an error in my Introduction to the above Tables. In a table on page xx the wrong argument has been inserted to the correct value of the function.

An errata slip has now been issued, and will be inserted in all future volumes sold. This slip will be supplied by the Sales Office, H.M. Stationery Office, Princes Street, Westminster, to all past purchasers of the work, and is arranged so that owners of the Tables can paste them over the offending matter.

I can only apologise sincerely to purchasers of the book for this inadvertency.

Karl Pearson.

Department of Applied Statistics,
University of London, University College, W.C.1.

The Nitrogen Industry.

By Prof. C. H. DESCH.

THE discussion on the nitrogen industry, organised by Section B (Chemistry) of the British Association at the Hull meeting, proved to be a great success in spite of certain obvious difficulties in the way of such a discussion at the present time. There are many processes in the field for the fixation of nitrogen, and commercial rivalries make it impossible to secure completely frank and unbiassed accounts of the merits of the various systems. Much information of great scientific value has, for commercial reasons, to remain unpublished. The Section was therefore fortunate in obtaining a general survey of the subject from Dr. J. A. Harker, whose experience in this field during and since the war was exceptionally great, his practical acquaintance with most of the competing processes enabling him to take an impartial view of many controversial matters. His paper makes it easier for chemical readers to judge of the value of statements appearing in the technical periodicals and in the popular Press. According to Dr. Harker, there is little to be added in the way of statistical material to the Report of the Nitrogen Products Committee published some eighteen months ago, while the fluctuations in the German exchange make it quite unprofitable to discuss German conditions of production or the possibility of dumping, topics which would otherwise have been attractive to the author of such a paper. The nitrogen question has attracted so much public attention that it has even found its way into school examination papers, although profound ignorance on the subject prevailed five or six years ago, not only among the general public, but also in the circle of high officials directly concerned with questions of national importance.

The oldest process for the synthesis of nitrogen compounds from atmospheric nitrogen is that which employs the electric arc. The great plants in Norway, of immense size and working with the greatest success, are avowedly derived from the laboratory apparatus of the late Lord Rayleigh, and Prof. Birkeland stated that his decision to establish the process as an industrial one was based on the famous presidential address to the British Association by Sir William Crookes. Lord Rayleigh's experiments included the measurement of the relation between the energy consumed and the nitrogen fixed, and it is a striking fact that even now less than two per cent. of the energy of the average arc furnace is absorbed as chemical energy in the initial oxidation of the nitrogen. The modern plants are of enormous size, the two plants at Rjukan, for example, employing a total of 200,000 kilowatts, generated at an astonishingly low cost by means of water power. Several modified arc processes have been tried experimentally, including the Kilburn Scott three-electrode furnace. The use of enriched air has been tried on a large scale by a company having works in Switzerland and Germany, a closed circuit being used, and the nitrogen peroxide removed by cooling instead of absorption. This operation is not free from danger, and serious explosions have taken place. The arc furnace plants erected in France during the war have been closed, the power plants being required for their original purpose, the electrification of railways.

Of the many processes for the production of synthetic ammonia, the original Haber process, the most familiar of all, has been successfully worked by the Badische Co. at Oppau, and at the even larger works recently completed at Merseburg in Saxony. The pressure in this process is 200 atmospheres, which is not now regarded as high, and the gases move slowly through reaction vessels 40 feet long and 3 feet in external diameter, the walls being 6 inches thick. The gases are pre-heated and circulated. The process worked out at University College, London, by the Nitrogen Products Committee uses higher gas velocities, and was planned to yield about 5 kgm. of ammonia per hour for each litre of space filled with catalyst, instead of 400 gm. as in the Haber system. The first American plant at Sheffield, Alabama, used activated sodamide as the catalyst, but it is not surprising, in view of the action of water vapour on this substance, that it proved a failure; the later modified plant of the Solvay Process Co., now making liquid ammonia for the refrigerating industry, has avoided the defects.

The Claude process uses very high pressures of 900-1000 atmospheres, and the issuing stream contains as much as 25 per cent. of ammonia. Circulation is replaced by multiple stage working, and the reaction vessels, made by a Sheffield steel firm from a special heat-resisting material, are surprisingly small. Hydrogen is to be produced by an improved process from coke oven gas. Electrolytic hydrogen is used on several plants, notably at Terni in Italy, and it seems likely that where water power is cheap, hydrogen can be economically prepared by this means, provided that the form of the cell can be improved.

Cyanamide, regarded by some as obsolete, remains the cheapest form of combined nitrogen, but in spite of this, many of the war works using this process have been closed. The largest plant is that of the American government at Mussel Shoals, the future of which is still uncertain. The German cyanamide plants are being increased in size. A disadvantage of this compound for agricultural purposes is that it is liable to change into dicyandiamide, but attempts are being made to convert it into other more valuable compounds. One American company is converting it into a mixed fertiliser, ammonium phosphate, which is useful but at present too costly. In Switzerland the calcium cyanamide has been converted to free cyanamide by carbonic acid, and then into urea. Mixed with monocalcium phosphate, a product known as phosphazote is obtained, and this substance is used for vines, the cost not being high. Mixed salts containing ammonium nitrate have suffered in popularity through the Oppau explosion, but the use of powerful blasting cartridges, which caused that explosion, is indefensible.

The cyanide process, the oldest of all nitrogen fixation processes, is in use in America for making the acid for plant fumigation, and researches are in progress with the object of cheapening the manufacture.

In concluding his paper, Dr. Harker directed atten-

tion to the large increase in the German capacity to produce synthetic nitrogen compounds, and the erection of new plants in that country. At the end of this year Germany will be independent of all importation of nitrates, while the large munition works in this country are being dismantled. The subject, therefore, has political importance as well as scientific and commercial interest.

Mr. J. H. West's paper dealt with the manufacture of the nitrogen and hydrogen required for synthetic ammonia processes. Three volumes of hydrogen being required for one of nitrogen, and the former being the more expensive gas, the cost of the process depends mainly on that of the hydrogen. The electrolytic process is convenient, and yields pure hydrogen, but the capital cost of the plant is high, and the method is only practicable where cheap hydro-electric power is available. Coke oven gas may be used, the method employed being that of liquefying all the gases present except hydrogen, but in this case the small quantity of carbon monoxide which always remains mixed with it must be removed by chemical washing or by conversion into methane, the gas being a poison to the catalyst in the subsequent ammonia synthesis. Water gas may be used, a reaction with steam being brought about in presence of a catalyst: $CO + H_2O = CO_2 + H_2$. In a modified process, due to the author and A. Jacques, the coal is treated by a process of complete gasification, and the gaseous products treated in the same apparatus to yield carbon dioxide and hydrogen with a catalyst. Nitrogen is made by the liquid air process, or by mixing air and hydrogen in such proportions that on passing over a suitable catalyst the oxygen is converted to water, and a mixture of nitrogen and hydrogen in the required proportions remains. In the Haber process, water gas and producer gas are mixed in such proportions that a correct mixture is left after removal of the carbon monoxide.

Both this paper, and the succeeding one by Mr. C. J. Goodwin, were presented in the absence of their authors, so that they suffered in the discussion. Mr. Goodwin described the Häusser process for the production of nitric acid by exploding nitrogen and oxygen with a fuel gas in a bomb. Although the plant has hitherto been on an experimental scale, it is expected that the new bombs of 1200-1500 litres capacity will give commercial yields, and the use of stainless steel has overcome much of the corrosion difficulty. The absorption towers have been greatly reduced in size by employing nickel-chromium steel or silicon-iron for the vessels, under a pressure of 2·5-4 atmospheres. The suggestion has been made that a special gas engine or Humphrey pump might be used in place of a bomb, in order to utilise the heat energy of the fuel more economically, but it remains to be seen whether such a change would prove advantageous on the whole. The main advantage of the process is its compactness, the size of the plant being small, especially when gases of high calorific value are used.

Dr. E. B. Maxted's contribution concerned the question whether nitrogen fixation, based on water power, could be economically undertaken in this country. Under present conditions, there are several sites in these islands where it should be possible to produce hydro-electric energy for *4l.*-*5l.* per kilowatt-year, the greater part of this sum representing interest on the capital cost. This would allow of the production of electrolytic hydrogen at a cost of *1s. 7d.* per 1000 cubic feet, which does not compare unfavourably with the cost of hydrogen from fuel. Greater economy would be effected if uses for large supplies of oxygen in the chemical industries could be found. Comparing together the ammonia and cyanamide processes, it appears that a given amount of power, say 10,000 kilowatts, being available, either process would result in the fixation of about the same quantity of nitrogen, but the ammonia process would yield large quantities of oxygen as a by-product, while the cyanamide process would require the bringing of anthracite and lime to the site. There would be some compensating conditions, such as the greater simplicity of the cyanamide process, and the necessity of fixing ammonia by means of an acid.

Mr. E. Kilburn Scott denied the contention that the arc process is uneconomical. It has been stated that in Norway nitric acid could be made profitably where electric energy costs *10l.* per kilowatt-year, while the Scottish schemes can provide the same quantity for *4l.* The arc process is the only one capable of utilising off-peak power, and where large generating stations are set up it is quite economical. Moreover, calcium nitrate is the best of all artificial fertilisers. Little else emerged in the discussion. It is clear that processes which promised well during the exceptional conditions of the war have to be re-examined very carefully in regard to their practicability under ordinary conditions of competition, and it has yet to be demonstrated that synthetic processes can be established successfully where power has to be obtained from the combustion of coal. Whatever may prove to be the future of these processes, Dr. Harker's review of the present position of the question will be of value, as an addition to the important memoirs already published from official sources.

The Thermal Basis of Gas Supply.

By Prof. JOHN W. COBB.

THE amount of attention which has been given in the Press during the past few months to the new basis of charge for gas introduced by the Gas Regulation Act of 1920, is at first sight somewhat surprising and unexpected. To the scientific mind there seems to be so little in it that calls for mental strain in its comprehension, or for criticism in its introduction.

Gas is now to be sold at so much per therm, and the therm is simply 100,000 British Thermal Units—*i.e.* a convenient multiple of what is the most widely known and generally accepted unit of heat. A

decision having once been taken to charge for gas on a thermal basis, the choice of such a unit was natural if not inevitable. It is true that the justice of making the potential heat units in the gas the sole measure of its usefulness is not to be established completely by *a priori* considerations, although most of us would probably be inclined to look kindly upon the notion from the beginning. There are factors other than potential heat content which might help to determine the value of gas in use, and should, therefore, be considered, such as the temperature attainable on combustion. If these factors were of sufficient importance the assumption that thermal units alone could be rightly taken as determining price would be invalid and a different basis for charging necessary.

Such matters as these were, however, discussed at length in conferences called by Sir George Beilby for the purpose, before the Fuel Research Board made the recommendations to the Board of Trade on which the Act was based. At these conferences the experience and the judgment of gas users and makers were freely drawn upon, and the results of experimental work bearing directly upon the points at issue, made by the Joint Research Committee of the University of Leeds and the Institution of Gas Engineers, were considered. The result was an acceptance by all parties of the principle establishing a thermal basis for the sale of gas. It was accepted that the legislative control of the gas industry, necessary because it is a public service with certain exclusive rights, must be made more elastic in some fundamental respects if the gas industry was to be able to take advantage of technical developments presented to it, and to realise fuel and monetary economies, so obviously desirable at the present time for the public good and its own interests.

The magnitude of that industry and the national importance of improvements effected in it may easily escape notice. The gas industry does not dominate any particular town or locality in the same way that steel dominates Sheffield or Middlesborough, or cotton some of the Lancashire towns, but in estimating the importance of the industry it should be remembered that every city and town and many a village throughout the country has its gasworks, carbonising a total of eighteen million tons of coal per annum, and incidentally employing a capital of some 150 million pounds.

The greater elasticity of control to which reference has been made above included a permission to each company or authority to supply gas of the calorific value which it could produce most economically, although the calorific value being declared a close adherence to the standard was to be secured by systematic outside inspection and testing, in which the recording gas calorimeter was to play a prominent part. On this system one town may be supplying gas of 550 British Thermal Units per cubic foot, and another a 450 gas. Comparison of charges cannot be made fairly on the price per 1000 cu. ft. alone, but requires a correction for calorific value. Charging by the therm, *i.e.* by the potential heat units carried by the gas, simplified the matter by introducing a common denominator.

To Sir George Beilby and others, including the writer, there seemed to be no difficulty in such a change or objection to it from the consumer's point of view. In justice to the gas industry it may be said that when the matter was under discussion its representatives declared themselves as being apprehensive of the way in which this strange new mode of making out a gas bill would be viewed by some consumers, and, through the ministrations of a certain section of the Press, this apprehension seems to have been justified for the time being.

An explanatory pamphlet bearing "The Therm"[1] as its title has just been issued by the Department of Scientific and Industrial Research (to which the Fuel Research Board is attached) in which the reports of the Fuel Research Board on "Gas Standards" have been reprinted. It is issued at a very low price, presumably with the hope of securing many readers and of placing the public in a less confused state of mind on a question in which a large section has a very direct interest.

There is something to be said for this hope. The only fear is that these reports, although well and clearly written, are somewhat too technical in content and language for the layman. Moreover, although this does not affect the main issue, one disadvantage arises from the fact that although the operative Act is based upon the recommendations of the Fuel Research Board as detailed in the pamphlet, there are some points of difference between the two which might have been indicated.

But it is surely plain enough, answering the question usually asked, that no increase in a gas bill can be rightly attributed to the use of the therm as the basis of charge. If a consumer has burned 2000 cu. ft. of gas with a calorific value of 500 British Thermal Units per cu. ft. he has used 10 therms, and it is a matter of indifference whether he is charged 4*s*. 2*d*. per 1000 cu. ft. or 10*d*. per therm; the same volume and calorific value determine the sum in each case and he pays 100*d*.

It is true that according to the Act, when a gas-supplying company or authority comes under the new scheme an increase in price may be authorised by the Board of Trade "in order to meet unavoidable increases since the 30th day of June 1914 in the costs and charges of, and incidental to, the production and supply of gas by the undertakers," but that is another matter, and has nothing to do with the use of the therm as the unit of measurement.

Moreover, although it is possible such increase of price may be authorised as essential, in some cases and for the time being, to the stability of a service which must be maintained in the public interest, it is widely recognised inside and outside the gas industry that the full development of public gas supply, with all the undoubted benefits it can confer upon the community, can be attained only through the medium of a cheaper gas. In the opinion of the writer it is also true that, in spite of misleading indications of the moment, the Gas Act of 1920 with its thermal basis of charge is well calculated to stimulate a continuous and general movement in that direction which will become more apparent in the future.

[1] The Therm. Reports of the Fuel Research Board on Gas Standards. (London: Stationery Office, 1922.) 3*d*. net.

Obituary.

Prof. A. Crum Brown, F.R.S.

Alexander Crum Brown was born at Edinburgh on March 26, 1838. His father was Dr. John Brown, minister of Broughton Place United Presbyterian Church; his mother was a sister of Walter Crum, a chemist of distinction. Educated at the Royal High School and at the University of Edinburgh, he graduated as M.A. in 1858 and as M.D. in 1861. In the following year he was awarded the D.Sc. degree of London, and thereafter studied in Germany under Bunsen and Kolbe. Returning to Scotland in 1863, he began his career in Edinburgh as an extra-mural lecturer in chemistry. For six years he taught small classes of medical students and busied himself with research. On the election of Prof. Lyon Playfair in 1869 to represent the University in Parliament, Crum Brown was appointed to succeed him in the chair of chemistry. The department placed under his charge was at first purely medical, but during his tenure it gradually changed its character, and at his retirement in 1908 had become one of the chief departments in the Faculty of Science.

Crum Brown was a man of extraordinary mental activity. The mention of a new subject sent his mind darting and exploring in all directions. In a few moments some pithy saying, some apt suggestion, or perhaps some awkwardly pointed question would be the outcome, showing his instantaneous grasp of the problem and his insight into its implications. That he was a pioneer far in advance of his contemporaries may be seen in the thesis which he presented at the age of twenty-three for the degree of Doctor of Medicine. It was entitled "On the Theory of Chemical Combination," and displayed such originality of thought as earned it a most discouraging reception, so that the author was deterred from publishing it at the time, and only printed it for circulation among his friends eighteen years later. Even to-day this thesis of 1861 bears a modern aspect, polarity and interatomic forces being at the basis of the presentation, and graphic formulæ being freely used. A pioneering research on the function of the semicircular canals in regard to the sense of balance and rotation, and another (in conjunction with Fraser) on the relationship between physiological activity and chemical constitution, illustrate his fertility of mind. Essentially of a speculative and philosophical turn, he yet invented many practical devices and supervised many practical researches. His name will always be associated with the rule for position isomers in benzene compounds and with the electrosynthesis of dibasic acids. He became a fellow of the Royal Society in 1879, and was an honorary graduate of all the Scottish Universities. During the years 1892 and 1893 he was president of the Chemical Society.

Apart from his chemistry, Crum Brown was of the widest general culture, and his mastery of languages assumed in Edinburgh circles almost legendary form. His business ability was utilised by his University, his church, and by the Royal Society of Edinburgh, of which he acted as secretary for a quarter of a century. In social gatherings he shone by reason of his wit and his gifts as a raconteur.

Two years after his retirement from University duties, his life was shadowed by the loss of his wife, a daughter of the Rev. James Porter, of Drumlee, Co. Down. Gradually failing bodily health confined him to the house for the past six years, but his mental ability remained unimpaired. His friends could always enjoy the refreshment of a talk with him—a talk sure to abound with quaintly apt stories and interesting reminiscences. After a few weeks' illness he died peacefully on October 28, the last representative of an academic period of singular brilliance.

Prof. J. P. Kuenen.

The unexpected death of Dr. Johannes Petrus Kuenen on September 25, having taken away from the University of Leyden in the full vigour of life a beloved professor, who only a few days before was invested with the dignity of Rector Magnificus, means a heavy blow to his many friends and in particular to myself. Kuenen returned to Leyden sixteen years ago, and since that time I shared with him the laboratory where he was one of my first pupils. He was born in 1866 and matriculated in 1884 in Leyden, where his father, the celebrated critic of the Old Testament, was then professor. By a life of idealism according to a tradition handed down from father to son he fulfilled the expectations which he then awakened.

As early as 1889 Kuenen became assistant in my laboratory. In 1892 he took his degree on a gold medal prize paper, and in 1893 he lectured as a privat docent. His brilliant experimental researches opened to him a career in Great Britain. After having worked for a time in Ramsay's laboratory, he was appointed professor in Dundee. In a touching letter Sir James Walker tells me how he was struck by the tall and handsome young Dutchman, the first meeting being the beginning of a friendship for life. When we read in Leyden that Kuenen was from the first a success in Dundee, both with his students and his colleagues, that he contrived to do in very adverse circumstances a considerable amount of research work, and that Sir James Walker admired the simple way in which Kuenen overcame experimental difficulties, we see that his friends both at Dundee and Leyden have the same vivid recollection of him. And when Sir James Walker reminds us of Kuenen's genial manner, of his quiet humour in conversation, and of his singing Schubert's songs, it is as if we hear Kuenen here in the laboratory, and with deep mourning we recall the ennobling influence of his presence and the happiness he spread around him everywhere he went by his kind and sunny heart.

Having declined different calls from Holland he accepted that from Leyden in 1906, where he took upon himself the teaching of one of the courses to which Lorentz had consecrated a good deal of his precious powers. Welcomed here with the greatest joy, he immediately exerted a great influence on our scientific life. He earned the profound gratitude of his pupils and general admiration for his love for science, his deep learning and insight, modesty, and unselfishness. To his unlimited helpfulness we have all been

highly indebted, and myself more than any one else. He gave me all that a younger partner can give to the older one. He took an enthusiastic part in the development of the Leyden laboratory, where he was to take over my part of the work. The plans for the extension of the laboratory in which he had all the time worked in a very disadvantageous location, were all made in conjunction with him. It is a great pity that he has been taken away before the beautiful new buildings for his department could be opened. We had both assisted in the preliminary dedication by putting, according to local use, the flag on the roof.

His many-sidedness made him spread widely the benefits of science and of its culture. He wrote, *e.g.*, an extensive and most interesting history of the development of physics in Holland during the last 150 years.

The main part of Kuenen's work lies in thermodynamics. He wrote many papers on it and also lucid and comprehensive books treating the equation of state and the equilibrium of liquid and gaseous phases of mixtures. By his masterly repetition of Galitzine's experiments he much aided science, proving that they could be explained by the influence of small admixtures.

The great achievement of Kuenen was his fundamental work on gaseous mixtures. He was the first to fill out experimentally for a complete series of mixtures of two gaseous substances in different proportions, a surface diagram that can be considered as the analogue of Andrews' line diagram for a single substance. The genius of van der Waals, then depressed by deep mourning, took a new flight when he was asked to work out in connexion with Kuenen's measurements his theory of binary mixtures given before only in sketch. Kuenen discovered then retrograde condensation, and from van der Waals' more extended theory deduced a complete explanation of this process. I still hold in vivid remembrance how Kuenen, putting in action his magnetic stirrer, the simple but fundamental contrivance by which he succeeded in eliminating retardation, had the satisfaction of demonstrating to van der Waals the retrograde condensation, and of seeing van der Waals looking in deep reflection at the beautiful phenomenon, which at once put his theory beyond any doubt. An admirable interaction of Kuenen's experiments and van der Waals' deductions followed.

Kuenen's discovery of mixtures with minimum critical temperatures and maximum vapour pressures led to many important discussions on the properties of the transversal plait on the free energy surface for the mixtures. A happy extension of his research, partly with Robson, was the study of different pairs of substances, which are not miscible in all proportions in the liquid state. It brought experimental material for the investigation of the longitudinal plait in connexion with the transverse one, where the theory of plaits of Korteweg had to be combined with van der Waals' theory, forming an imposing whole, that showed the way in what seemed once a labyrinth. A posthumous work of Kuenen with Verschoyle and van Urk continuing the work with Prof. Clark on the retrograde condensation of mixtures of oxygen and nitrogen makes the last as well as the first of his papers belong to his great life-work. Kuenen leaves incorporated in science a diversity of images systematising in the light of theory the full life of concrete facts in a wide domain and constituting a lasting monument to his genius. H. KAMERLINGH ONNES.

DR. ALBERT A. STURLEY, instructor in physics at Yale University, and formerly professor of physics in the University of King's College, Windsor, Nova Scotia, died in New Haven, Connecticut, U.S.A., on October 22, at the age of thirty-five years.

Current Topics and Events.

H.M. THE KING has approved of the following awards this year by the president and council of the Royal Society: A Royal medal to Mr. C. T. R. Wilson, for his researches on condensation nuclei and atmospheric electricity; and a Royal medal to Mr. J. Barcroft, for his researches in physiology, and especially for his work in connexion with respiration. The following awards have also been made by the president and council: The Copley medal to Sir Ernest Rutherford, for his researches in radioactivity and atomic structure; the Rumford medal to Prof. Pieter Zeeman, for his researches in optics; the Davy medal to Prof. J. F. Thorpe, for his researches in synthetic organic chemistry; the Darwin medal to Prof. R. C. Punnett, for his researches in the science of genetics; the Buchanan medal to Sir David Bruce, for his researches and discoveries in tropical medicine; the Sylvester medal to Prof. T. Levi-Civita, for his researches in geometry and mechanics; and the Hughes medal to Dr. F. W. Aston, for his discovery of isotopes of a large number of the elements by the method of positive rays.

THE Royal Swedish Academy of Sciences, Stockholm, has awarded the Nobel prizes for physics and chemistry for 1921 and 1922 as follows: Physics, 1921, Prof. Albert Einstein, Berlin, for his theory of relativity and general work in physics; 1922, Prof. Niels Bohr, Copenhagen, for his researches on the structure of atoms and radiation. Chemistry, 1921, Prof. F. Soddy, Oxford, for his contributions to the knowledge of the chemistry of the radioactive elements and the nature of isotopes; 1922, Dr. F. W. Aston, Cambridge, for his investigations of elements and isotopes with the mass-spectrograph. The Nobel prize for medicine is reserved for next year, and that for peace will be announced on December 10, the anniversary of the death of Alfred Nobel, when the prizes will be presented by the King of Sweden.

THE well-known periodical, *Curtis's Botanical Magazine*, which appeared regularly from its foundation in 1787 until the end of 1920, has now fortunately reappeared under new auspices. The first part of Volume 148 has just been published by Messrs. H. F.

and G. Witherby, for the Royal Horticultural Society, the new proprietors of this valuable publication, and the Society has been so fortunate as to secure Dr. O. Stapf, late Keeper of the Herbarium and Library of the Royal Botanic Gardens, Kew, as editor. The long connexion between Kew and the magazine will thus, we hope, be maintained in the future as in the past, and in fact the legend on the cover which states, "Hand-coloured figures with descriptions and observations on the Botany, History, and Culture of new and rare Plants from the Royal Botanic Gardens, Kew, and other Botanical Establishments," gives good assurance that this will be the case. Indeed it is difficult to imagine that a work of this kind, to be of real value, could be prepared without the close connexion with Kew being fully maintained. This part, the first of the new venture, is one on which the new proprietors as well as the editor and publishers deserve to be highly congratulated. The plates are beautifully drawn and are both accurate and artistic, while the colouring leaves very little to be desired. There is the same fidelity to botanical detail with which readers of the older volumes are familiar and which makes the plates of so much value. The drawings in this part are the work of three different artists, and we think it is not undue praise to say that they are worthy of the magazine in its best days. The beauty and fidelity of such plates as those of *Stapelia tsomoensis*, a very difficult subject; *Bulbophyllum triste*, a delicate and very remarkable orchid from India, and *Symphytum grandiflorum*, leave nothing to be desired. An ample description both in Latin and English accompanies each plate, and there is much additional matter of an interesting and very useful nature. The English descriptions might possibly be somewhat abbreviated and also some of the general discussion, but it is all of value and shows how much care and trouble the editor must have spent to produce the letterpress, which is a mine of useful information. A volume for the year 1921 to preserve the continuity of the magazine is being prepared by private enterprise.

THROUGH the courtesy of Admiral of the Fleet Sir Henry B. Jackson, chairman of the Radio Research Board under the Department of Scientific and Industrial Research, we are able to publish this week an article on "The Origin of Atmospherics" by Mr. R. A. Watson Watt, who is in charge of the Board's Research Station at Aldershot. The interesting results described will no doubt receive close attention from the scientific public. The members of the Radio Research Board and of its Sub-Committee on Atmospherics who are responsible for the investigations carried out at the Aldershot Station are as follows: *Radio Research Board*.—Admiral Sir Henry B. Jackson (chairman), Captain C. E. Kennedy-Purvis, Lieut.-Col. A. G. T. Cusins, Wing-Commander J. B. Bowen, Mr. E. H. Shaughnessy, Sir Ernest Rutherford, Sir J. E. Petavel, Prof. G. W. O. Howe, Mr. O. F. Brown, and Mr. L. C. Bromley (secretary). *Sub-Committee B on Atmospherics*.—Colonel H. G. Lyons (chairman), Prof. S. Chapman, Major H. P. T. Lefroy, Mr. A. A. Campbell Swinton, Mr. R. A. Watson Watt, Mr. G. I. Taylor, Mr. C. T. R. Wilson, Mr. H. Morris Airey, Dr. G. C. Simpson, and Mr. O. F. Brown (secretary).

AT a general meeting of the Royal Scottish Geographical Society, held on November 7, the Society's gold medal was awarded to Prof. J. W. Gregory, University of Glasgow, in recognition of the scientific importance of results obtained by him through explorations in Spitsbergen, Australia, East Africa, and South-west China.

THE Thomas Hawksley lecture of the Institution of Mechanical Engineers will be delivered at 6 o'clock on Friday, December 1, by Dr. T. E. Stanton, who will take as his subject, "Some Recent Researches on Lubrication."

MR. R. T. A. INNES, the Union Astronomer at Johannesburg, who is at present in Paris and will be in England in a few weeks' time, has had the degree of doctor of science, *honoris causa*, conferred upon him by the University of Leyden.

THE following new appointments in the Peabody Museum of Natural History have recently been announced by Yale University: to be director, Dr. R. S. Lull, professor of vertebrate palæontology; to be curator of mineralogy, Dr. W. E. Ford, professor of mineralogy, in succession to Prof. E. S. Dana, who has held the curatorship since 1874.

IN connexion with the Liverpool section of the Society of Chemical Industry a Hurter Memorial Lecture will be delivered at 8 o'clock on Wednesday, November 22, in the Chemistry Lecture Theatre of the University, Liverpool, by Mr. W. Macnab. The subject will be "Some Achievements of Chemical Industry during the War, in this Country and in France."

THE council of the Institution of Civil Engineers has made the following awards in respect of papers printed without discussion in the Proceedings for the session 1921–1922: A George Stephenson gold medal to Dr. B. C. Laws (London); Telford premiums to Prof. L. Bairstow (London), Dr. A. J. Sutton Pippard (London), Mr. E. A. Cullen (Brisbane), Mr. H. H. Dare (Roseville, N.S.W.), and Mr. F. W. Stephen (Aberdeen). And for papers read before meetings of students in London and the provinces: A Miller prize and the James Forrest medal to Mr. F. H. Bullock (Cardiff); and Miller prizes to Mr. J. G. Mitchell (London), Mr. A. G. M'Donald (London), and Mr. Harry Wolf (Manchester).

THE twenty-fifth annual Traill-Taylor memorial lecture was delivered by Dr. Reginald S. Clay at the house of the Royal Photographic Society on October 10, and is printed in full with numerous illustrations in the November number of the Society's Journal. The subject was "The Photographic Lens from the Historical Point of View," and the discourse is probably the most complete, if not the most extensive treatment of the subject now available. The lecturer referred to "two great inventions"—first, the anastigmats of Schroeder, Rudolf, and von

Hoegh, and second, the Cooke lens of Harold Dennis Taylor, and remarked that only time can show which of these has been of greatest value, and upon which, if either, the objective of the future will be based. He adds, "I do not think the great step which the Cooke lens marks is as well appreciated here as on the Continent . . . the Zeiss Unar and Tessar were based on the same principle as the Cooke lens. . . . Harting has also made several lenses which are modified Cookes."

THE Optical Society of America held its seventh annual meeting and exhibition of optical instruments at the Bureau of Standards, Washington, on October 25-28. Special sessions were arranged for the consideration of radiation, atmospheric optics, physiological optics, photometry, optical pyrometry and photography, and the whole process of manufacturing optical glass was available for inspection during the meeting. Reports of committees which have been considering the combination of the Journal of the Society with the Instrument Makers' Journal and the possibility of publishing a translation of Helmboltz's "Physiologische Optik" were received. Informal accounts of the present position of the work of the committees on nomenclature and standards of polarimetry, reflectometry, spectroradiometry, refractometry, visual sensitometry, optical glass and instruments, wave-lengths, illumination and photometry, photography, pyrometry, and spectrophotometry were also given. Visitors not members of the Optical Society were allowed at both meetings and exhibitions of apparatus.

THE annual report of the Chief Medical Officer of the Ministry of Health for the year 1921, recently issued, is entitled, "On the State of the Public Health." The death-rate for that year was 12·1 per 1000 persons living, the lowest on record; the birth-rate 22·4, a decline of 3·1 on the previous year. The infant mortality was 83 per 1000 births, a very low figure, though slightly higher than that of 1920. Of 1000 deaths from all causes, cancer accounted for 100, bronchitis for 73, pneumonia for 76, heart diseases for 117, and nervous diseases for 105. As regards infective diseases, no cases of plague, cholera, or typhus fever occurred, and influenza remained at a very low ebb during the greater part of the year, but 336 cases of smallpox were recorded. Only 12 new indigenous cases of malaria were detected, as compared with 36 in the previous year and 103 in 1919. Encephalitis lethargica increased, 1470 cases being recorded, as compared with 844 cases in 1920. Tuberculosis is decreasing, the number of cases notified being the lowest recorded. Much information is given on schemes for maternity and child welfare, on the prevention of venereal diseases, on the care and after-care of tuberculous cases, on the relation of food to health and disease, and on the medical and sanitary administration of the country.

IN *Scribner's Magazine* for November, Dr. George E. Hale describes the buildings now being erected in Washington for the National Academy of Sciences and the National Research Council. The architect is Bertram Grosvenor Goodhue of New York, and the sculptural decoration has been entrusted to Lee Lawrie. The complete plan is a hollow square with a frontage of 260 feet, the centre of which will be occupied by a domed hall surrounded by seven top-lit exhibition rooms. For the present only this central area and the front block are being erected. The two upper floors of the front block will contain the offices of the Academy and the Research Council; the entrance hall on the ground floor will be flanked by a library, lecture-rooms, and conference rooms. The central hall, though primarily intended for exhibits, will be capable of transformation into a lecture-room or meeting-room. The novelty of the scheme lies in the utilisation of the central space for a museum of discovery. Those natural phenomena which for the time being provide the chief fields of investigation, the apparatus for studying them, and the means by which fundamental discoveries in pure science are applied for the public welfare will all be demonstrated in a permanent but ever-changing exhibition, kept constantly up-to-date, and covering the whole range of the physical and biological sciences. At the same time the provision of a convenient and dignified headquarters for the National Academy and the Research Council will greatly assist those two bodies in their tasks of advising the Government and organising the scientific work and resources of the United States. The building will doubtless justify the title of Dr. Hale's article as "A National Focus of Science and Research."

THE annual report of the Lancaster Astronomical and Scientific Association has recently been received. The rules and regulations of the Association are such as could with advantage be imitated and followed by many other similar institutions up and down the country. It is apparently conducted entirely by honorary officials, and the motto borne by the Association is clearly the whole spirit of the work—"If we succeed in giving the love of learning, the learning itself is sure to follow"—Lord Avebury. The Association has a total of 281 members. Lectures are given monthly and they are of a scientific and educational character. Meteorology forms an important feature of the report. Monthly and weekly results from readings taken at the Greg Observatory are sent to the Meteorological Office and are used in the official publications. Mean values for each month throughout the year 1921 are given in the report for barometer as well as the extreme readings, the duration of bright sunshine and the number of sunless days. Monthly rainfall statistics are tabulated, and during 1921 the total measurement was 41·25 in., which fell on 194 days. Lancaster escaped the drought from which so many other places suffered, and the showers during the summer kept the ground from being dried up. The mean air temperature for the year was 50°·2 F., which is warmer than either of the two preceding years.

THE recently issued report of the museums of the Brooklyn Institute (N.Y.) for 1921 shows that the children are well catered for, not only in the delightful

Children's Museum, but also at the Central Museum. Here it is the higher grade schools that receive chief attention, and an attempt is made to correlate the demonstrations with their curriculum. Besides the classes at the Museum, full use was made of the collection of lantern slides, more than 2800 being sent out on loan. The department of ethnology continues to furnish suggestive material to the American clothing and allied industries; four rooms have been constructed and equipped for the increasing number of artists and manufacturers consulting these collections.

ONE way in which the Smithsonian Institution pursues "the increase of knowledge" is by exploration and field-work. A richly-illustrated pamphlet describing the work so accomplished during 1921 has been issued as Publication 2669. The prevailing high costs restricted the number of expeditions, but fourteen of the more important ranged from China to Chile and brought back large collections to the United States National Museum. Our own museums do their share of exploration, but the great advantage possessed by the museum at Washington is that it seems able to detail its own staff for this purpose. This is to the benefit of both the individuals and the eventual study of the collections. Dr. C. D. Walcott continued his exploration of pre-Devonian strata in the Canadian Rockies. Dr. Bassler collected fossils in Tennessee for study and for exhibition. Mr. Gilmore collected fossil vertebrates in New Mexico, and Mr. Gidley did the same in Arizona, California, and Nebraska. Dr. Hitchcock collected and studied grasses and bamboos in the Philippines, Japan, and China. Dr. Bartsch visited the Tortugas and the Bahamas in connexion with his breeding experiments on the mollusc Cerion. Dr. Aldrich was sent to Alaska to collect insects. Seven other expeditions were devoted to archæological field-work in the United States and Dominica, and on them also many members of the staff were engaged. The health and enthusiasm gained by this contact with Nature in the open air must be a great help to the workers during the rest of the year.

THE Geological Survey of South Africa has earned the thanks of a wide circle by publishing, as Memoir No. 18, "A Bibliography of South African Geology to the end of 1920" (Pretoria, 1922, price 10*s.* 6*d.*). Mr. A. L. Hall has undertaken what must have been an arduous task, and Miss M. Wilman has generously supplied him with the data collected by her since the publication of her "Catalogue of Printed Books, Papers, etc.," in 1905. The result is a clearly printed list, classified by authors, of 5794 entries, and covering even remarks put forward in the discussions that are so usefully printed in the Proceedings of the Geological Society of South Africa. The only slips that we have noticed are in one or two initials of authors, and here and there the omission of the place of publication or of a date. "Liège," which is used throughout, is of course a repetition of a common error. The whole question of a uniform system of abbreviations has still to be considered. "Jl." for Journal and "Ro." for Royal are unusual and unnecessary. "G.S., U.S.A." is misleading for a publication that has nothing to do with the senior Union across the Atlantic, and "Minn." means Minnesota and should not be used for Minneapolis. There should be no comma, though this has been systematically inserted, after the first "S" in "G.S.S.A." However, the complete list of serials quoted at the outset helps us over these small difficulties, and Mr. Hall's energy has cleared away a thousand greater ones from the path of the student of South African geology.

WITH the enormous increase in the production of petroleum and the widely different uses to which the commercial products are put, the various international congresses which met prior to the war, realising the importance of standard methods of testing, attempted to deal with the question internationally, but little practical success was achieved. With such products so many of the tests are empirical, depending, like the flash point and so-called viscosity, on the form of apparatus and conditions of testing, that standardisation is absolutely essential if the tests are to have real value. It remained for the greatest producing country, the United States of America, through that valuable body the American Society for Testing Materials, to accomplish successfully the work of standardisation of methods, and defining as accurately as possible the desired characters of the various products. In this country, which although not a producing country is one of the largest consumers and controls many important oil fields, the Institution of Petroleum Technologists decided last year that standardisation must be taken in hand, and at a meeting of the Institution on October 10 Dr. A. E. Dunstan gave a summary of the progress which had been made. Hearty support and assistance was given by all the Government Departments concerned with the use of oil products, and by the British oil companies, and co-operation with the British Engineering Standards Association, a body representing a most important section of users, has been arranged to deal with specifications. The work of standardisation has been divided between the six following sub-committees: naturally occurring bituminous substances (crude oils, etc.); distillates up to kerosene; kerosenes and intermediates; lubricants; liquid fuels; asphaltum and artificial residues. It is anticipated that the methods recommended will be issued early next year.

REFERRING to the article on "The Sense of Smell in Birds" in NATURE of June 17, Dr. B. S. Neuhausen, of Johns Hopkins University, Baltimore, writes to direct attention to a paper by Dr. H. H. Beck on "The Occult Senses in Birds" (*Auk*, 1920, xxxvii, 55). In this communication Dr. Beck gave an example of the great food-finding powers of carrion-eating birds. At a hunt, one frosty morning in Pennsylvania, a dog went mad and had to be shot: the body was thrown into a limestone sinkhole close at hand, where it was speedily located by turkey vultures, the nearest haunt of which was eight miles

away. One may readily agree with the author that a freshly killed dog would give off little odour at a temperature below freezing-point, and one must accept his opinion that the body was practically invisible in the hole; but there seems to be no conclusive evidence that the incident of the killing could not have been both seen and heard by the vultures. Dr. Beck's theory is that none of the ordinary senses suffices to explain events like this, and that some "occult sense," by which he means a sense not within the scope of our own subjective experience, must be invoked. He would have us believe that birds possess a special "homing sense" and a special "food-finding sense," while a "mate-finding sense" is mentioned as a third possibility. It seems more than doubtful, however, whether naming new senses adds anything to our knowledge of the subject. The idea of a sense has little meaning if divorced from the idea of a sense-mechanism, and a "food-finding sense" implies that food (a comprehensive term in the case of birds) is capable of acting as a direct and simple physiological stimulus through some unknown channel of perception which is independent of such more obvious properties of the food as its appearance and odour. Granted that birds have powers of perception transcending our subjective experience, it is surely more reasonable to attribute these to greater acuteness of the known senses than to imagine new senses for which no physiological basis can be suggested.

Our Astronomical Column.

FIREBALL ON OCTOBER 31.—In daylight on the early evening of Tuesday, October 31, at 5.10, an unusually brilliant meteor was observed from various places in the south of England, including Neath, Hereford, Bournemouth, Goring, Witney, and on the eastern boundary of South Wales. The accounts of its appearance, while they all testify to the startling lustre of the object, are yet imperfect and inexact in describing the course it traversed. There were only a few of the brighter stars visible at the time. On the basis of the available data it is impossible to compute a perfectly satisfactory real path for the meteor, but it appears probable that the radiant point was at $194° + 33°$, and that during its luminous flight the meteor was over the region from Brecon to Wiltshire, the height declining from 65 to 29 miles. Further observations would be valuable.

SOLAR PHYSICS OBSERVATORY, CAMBRIDGE.—The ninth annual report of the Director of the Solar Physics Observatory has recently been issued; in it is described briefly the work done during the year April 1921 to March 1922. The observations of two novæ, Nova Aquitæ III. and Nova Cygni III. (1920), have been under discussion; those of the former are expected to appear in Parts 2 and 3 of vol. 4 of the annals, while the latter have been communicated to the Royal Astronomical Society (Mon. Not. R.A.S. vol. 82, p. 44). The well-known variable β Lyræ has been investigated, and 64 spectrograms taken at Cambridge in 1921 and 96 taken in 1907 at the Allegheny Observatory are being reduced. It is stated that the indications of the results are that the system of β Lyræ contains probably at least four components in relative motion. Three lines of work relate to the investigation of the circulation of the atmosphere of the sun. The first is a detailed discussion of the shapes of the clustered masses of flocculi, recently referred to in this column, showing that these masses are inclined at certain angles to the solar equator. The second is a study of the proper motions of the sunspots and the movements of zones of prominence activity; while the third is the determination of the solar rotation by the spectroscopic method, also recently described. The observations and experiments in the department of meteorological physics have been continued. It is interesting to note that the mounting of the three-foot reflector will be completed since the staging has now been finished.

THE METEORS OF THE PONS-WINNECKE COMET.—Mr. G. Shain, of Pulkovo Observatory, discusses this meteor swarm in *Astr. Nach.*, No. 5190, noting that the agreement of the radiant with that calculated from the cometary orbit indicates a common tangent to the two orbits, but identity is only shown if they are found to have the same secular perturbations. It will be remembered that it was in this manner that Prof. J. C. Adams showed that the period of the Leonids must be about 33 years. Since the meteors seen in June 1916 were 10 months behind the comet, their perturbations by Jupiter in the ensuing revolution were different; the meteors made their nearest approach to Jupiter (distance 0·719) in mid-May 1918. The following are the calculated perturbations between May 1917 and May 1919: $\Delta\Omega - 65'\cdot 9$, $\Delta i + 41'\cdot 5$, $\Delta\pi + 59'\cdot 5$, $\Delta\mu - 13''\cdot 5$, $\Delta\phi - 45'\cdot 5$, and $\Delta q + \cdot 047$. The date of the chief display went back from June 28, 1916, to June 27, 1921, in good agreement with the above change of the node. The comet itself went still nearer to Jupiter than the meteors and suffered larger perturbations. Mr. Shain considers that the indications are all in favour of connexion between the comet and meteors, and notes that a similar shower was seen in early July 1867, 1868, 1869, 1872 by several observers.

KALOCSA OBSERVATIONS OF PROMINENCES.—The Rev. B. G. Swindells, S. J., gives a useful summary in the *Observatory* for October of the work on prominences by Father J. Fenzi at Kalocsa from 1886 to 1917. The curve of prominence activity is synchronous with that for the spots, but the distribution is different. At minimum the chief prominence-development is in latitude 50°. There are none at the poles and few at the equator. The prominence-zone extends towards the poles as maximum approaches and, for a short time at maximum, the poles are the seat of greatest prominence-activity. But a state of quiescence soon returns at the poles, not to be disturbed for nearly 11 years. It is as though two waves of activity start from lat. 50°, one filling the equatorial gap, the other approaching the poles from all sides, so that there is a great heaping-up there, which soon collapses again. While these changes are different from those of the spots, they accord with the changes in the coronal rays, so that the latter appear to be closely connected with the prominences. In some eclipses coronal arches have been seen surrounding prominences, which is a further argument for connexion. It is not difficult to imagine that the more finely divided matter expelled in a prominence-eruption should rise to a great height under such influences as light pressure and electrical repulsion.

Research Items.

THE MAORI MODE OF DRILLING.—In the last issue of the *N.Z. Journal of Science and Technology*, Mr. Eldon Best, of the Dominion Museum, contributes an article on the methods of drilling used by the Maoris. The type of drill formerly used by them was the cord drill, which was used in ancient days in India and is still employed in making the sacred fire. The pump drill and bow drill were unknown to the Maori in pre-European times. The European form of pump drill was introduced by the early European settlers. Had the Maori known the pump drill in former times, it would have been the free-bar drill used by the nations of the western Pacific. The pierced-bar form was not known in that region in ancient times, but was introduced by early European visitors and residents. Mr. Best gives three photographs showing the present use of the drill for piercing blocks of stone.

RELATION OF TRANSPIRATION TO DRY WEIGHT IN TOBACCO PLANTS.—Many experiments have been made to determine the relation between the rate of transpiration in a plant during its growth and the dry weight and ash content of the resulting plant. Lawes made some experiments on the subject as early as 1849. In a recent paper Mr. N. B. Mendiola (*Philippine Journ. of Sci.*, vol. 20, No. 6) describes series of experiments with tobacco plants grown in water culture, to determine the effect of a dry or humid atmosphere and of light or shade. He concludes that there is no absolute correlation between the percentage of ash, the relative rate of transpiration of the plant during its growth, and the total dry matter produced.

PHOSPHORESCENT LIGHT OF FIREFLIES.—Ever since the classic experiments of Langley, the light of the firefly has attracted attention on account of its presumed high efficiency and the hope that we may ultimately be able to produce synthetically substances yielding useful phosphorescent light. Some experiments by Dr. H. E. Ives, summarised in the Journal of the Franklin Institute, show that the brightness of the firefly is about 0·014 lumens per sq. cm. This may appear so low as to be of little practical value in comparison with the brightness of a typical white sky (about 1 lumen per sq. cm.) and it is, of course, far below the brightness of most artificial illuminants. Yet if we could obtain such a steady brightness synthetically, and cover fairly extensive surfaces with the phosphorescent substance, it would be possible to obtain a serviceable illumination. The examination of the distribution of energy in the spectrum of the firefly is attended by great difficulty owing to the feeble nature of the light. Dr. Ives employed two methods, photography with panchromatic plates and "extinction of phosphorescence," and deduced that the radiation is confined between 0·5 and 0·6 μ, which is the region of the visible spectrum where perception of light by the eye is most acute. His estimate of luminous efficiency is based partly on reasoning involving assumptions of the total energy of a glow-worm in relation to its weight, and is therefore somewhat dubious. But he conjectures that about 80 per cent. of the total radiated energy appears as visible light.

A NEW TEXTILE FIBRE.—The October issue of *Conquest* completes the third year of its publication, and throughout this period it has consistently carried out its purpose of setting forth the progress of science so far as it concerns our daily life. In this issue Mr. A. S. Moore directs attention to the possibilities of the new textile fibre "arghan," which Sir H. Wickham noticed in native use in South America and introduced four years ago into the Federated Malay States, where the authorities granted 30,000 acres for its cultivation. It is a plant of the pineapple type, and its leaves split readily into fibres 5 or 6 ft. in length, which resemble silk and exceed the best hemp and flax in strength. It resists the action of sea water, and will be invaluable for nets and ship cordage; it spins and bleaches well and retains all dyes, and makes a firm cloth when woven either alone or in combination with cotton or flax.

INDEXING SCIENTIFIC LITERATURE.—We have received from the National Research Council of the United States the reprint of a paper by Mr. Gordon S. Fulcher on "The Indexing of Scientific Articles" which deserves notice. Mr. Fulcher does not appear to be well posted in the literature of his subject, for he places in one category the "International Catalogue of Scientific Literature," and the indexes of the H. W. Wilson Co., which are prepared on entirely different principles. For example under the scheme of "The International Catalogue" a paper on the flora of Formosa would appear under its author's name, the geographical area of its flora, and under the new genera or species described. Similarly a paper of anthropological interest would be classed under its period, locality, and subject matter. Mr. Fulcher's scheme is practically on those lines; but he goes one step further by advocating the elimination of the author and title of the paper and substituting a series of notes, dealing with the salient features of each paper, which are subsequently arranged for printing in alphabetical order. Our objections to Mr. Fulcher's system are as follows: It is "in the nature of real things to be inexhaustible in content," hence if bibliographical unities are disregarded the extent of analysis must be arbitrary, and uniformity of work and phraseology rendered very difficult. To bring it within the range of practice such a scheme must be a classification of original matter arranged under agreed subdivisions. Under Mr. Fulcher's scheme the same subject appears under two or more sub-heads, *e.g.* Nebulæ: origin-planetary, etc. Nebulæ: planetary-origin, etc. Neither, however, of the above methods are adapted to the indexing of scientific papers. The elimination of the author's name divests the paper of its proper authority; while the substitution of the analytical note for the author's title destroys the unity and purpose of the article. A minutely-classified file of excerpts from the scientific journals prepared by some central authority would undoubtedly prove of great national service, but an index prepared on Mr. Fulcher's lines would probably be seldom consulted.

COLOUR FILTERS IN MICROSCOPY.—Messrs. Kodak have just issued the sixth edition of their booklet on photomicrography. It has been revised so that it now deals with cut films instead of plates, bringing it into line with Messrs. Kodak's practice of making films only on account of the many advantages that they offer. It includes for the first time details of a set of Rheinberg's filters for differential colour illumination in microscopy. Although this method of illumination was introduced by Mr. Rheinberg some 25 years ago, Mr. Rheinberg says that this is the first time that the discs and rings have been made commercially in a suitable form and in suitable colours. The book gives within its 40 pages a great deal of information on the adjustment of the apparatus, the use and properties of colour filters of all kinds, exposure factors, and so on.

The Origin of Atmospherics.[1]

By R. A. WATSON WATT.

THAT abnormal outbursts of atmospherics—the "x-storms" of the radio-telegraphist—were associated with convective weather was indicated by the work of the British Association Committee on Radio-telegraphic Investigations in 1914–15. That actual thunderstorms could be located by direction-finding on atmospherics was established early in a Meteorological Office investigation begun in 1915. But it has not yet been shown whether the fully developed thunderstorm is the only, a main, or merely a subsidiary source of atmospherics.

A critical examination of the data obtained in the Meteorological Office investigation referred to promises to throw some light on the question, and it has been thought desirable to give a preliminary indication of the evidence which is emerging.

The coastal direction-finding stations of the Admiralty co-operated in the investigation by reporting the apparent direction from which atmospherics were arriving whenever such a direction was observed, and when pressure of traffic permitted an observation.

Some twelve stations took part in this scheme, which began in March 1916. The examination of the results has been made for two years, April 1916 to May 1918. During this period there were approximately 1000 occasions on which three or more stations observed a direction of arrival of atmospherics within the same hour. On plotting these approximately simultaneous observations on a gnomonic chart, it is found that on almost exactly half of the occasions the three or more bearings gave an intersection in a point of a limited area, indicating a source of atmospherics at a point so determined. Actually the distribution of these intersections, according to the number of participating stations, is as follows:

Six stations giving bearings meeting in a point (within the limits of accuracy of observation)	2
Five stations giving bearings meeting in a point (within the limits of accuracy of observation)	15
Four stations giving bearings meeting in a point (within the limits of accuracy of observation)	68
Three stations giving bearings meeting exactly in a point	231
Three stations giving bearings meeting in a point after adjustment within the limits of accuracy, assumed ± 5 degrees	110
Three stations giving bearings failing to meet in a point but delimiting a small area as source	62
Total number of locations	488

The geographical distribution of these apparent sources of atmospherics is:

England and Wales	58	Central Europe and Balkans	12
Scotland	18	Mediterranean and N. Africa	44
Ireland	45	Iceland and Atlantic	9
English Channel	59	Belgium	7
Bay of Biscay	37	Holland	7
France	144	Switzerland	6
Spain	23		
Italy	19		

The comparison of these locations with meteorological data is a somewhat extensive investigation and is still in progress. In 288 cases, however, the immediately available data seemed to provide an adequate basis for discussion. In a relatively small number of cases only were thunderstorms found to have occurred in the region located as a source of atmospherics, and near the time of observation. Since the thunderstorm is a known source of atmospherics, it is not proposed to detail here these cases, particularly as it is necessary to search more closely for records of thunderstorms, which are notoriously sporadic phenomena, liable to slip unobserved through the open mesh of the network of observing stations.

Comparison was also made with the map in the British Daily Weather Report, which shows the area over which rain has fallen during the 24 hours, 7 A.M. to 7 A.M. In 239 out of the 288 cases, the apparent source of atmospherics was definitely associated with the rainfall area for the corresponding 24 hours. In 105 cases the source was on the advancing edge of the rain area, in 75 within that area, and in 59 cases it was on the rear edge. Of the remaining 49 locations, 30 were found to fall in places where thunderstorm or squall phenomena had been reported about the same time.

Thus in only 19 of the 288 cases, *i.e.* in 6½ per cent., has no meteorological relation with the source of atmospherics yet been traced, while it is also noteworthy that 10 of these 19 fell in the least trustworthy class of location, the three bearings delineating an area not negligibly small.

One is therefore faced with the alternative conclusions that—

(1) Rainfall, without the occurrence of a fully developed thunderstorm, is an important source of atmospherics.

(2) The climate of south-west Europe is so wet, that there is an extremely high probability of rain in a random 24 hours at a random point.

To test the validity of conclusion (2) the maps for the same two-year periods were used. Four individuals (two without knowledge of the nature of the test) were asked to carry out a blind spotting game by placing a random dot on each chart, without seeing its detail. Again, many of these dots were beyond the range of adequate data, but 335 out of 732 could be compared with data. The results show that the chances are nearly even for or against rain, the distribution of the random points being:

In rain area	73
On advancing edge	46
On rear edge	62
Total associated with rainfall	181
Total definitely not so associated	154

It appears, therefore, to be established conclusively that a very high proportion of sharply defined sources of atmospherics are to be found in areas in which rain is falling, and particularly on the advancing edge of such areas, more than 90 per cent. in the present series being in rain areas, and 36 per cent. on the forward edge of the 24 hours' rain area. It is perhaps a permissible inference that, were one able to deal with the instantaneous advancing edge instead of the edge of the area for the day, the latter figure would be increased.

The results of this investigation fall into line with modern views of the mechanism of rainfall and thunderstorm phenomena. The separation and accumulation of charges caused by ascending currents may be readily believed to be more pronounced on

[1] Published by permission of the Radio Research Board of the Department of Scientific and Industrial Research.

the forward edge of a rain area, and to stop short of actual thunderstorm formation, while still being sufficiently marked for the necessary readjustment of charge to originate electro-magnetic waves. The difficulty of picturing readjustments propagating radiation of such energy content as to produce audible atmospherics at distances of more than 1000 kilometres, without producing visible lightning or audible thunder at ground stations near the source, is considerable, but not so great as the difficulty of picturing sufficient "full scale" lightning discharges, or other known phenomena, to account for the reception of atmospherics at an annual average rate of more than one per second at a station in these latitudes.

The writer desires to acknowledge his indebtedness to the Meteorological Office and to the Radio Research Board, for providing the facilities for carrying out this work, and for granting permission to publish the results.

X-Ray Electrons.

AMONG the items of the programme of section A of the British Association at Hull this year, there was one of outstanding interest consisting of the description of some very beautiful experiments which apparently constitute still another triumph for the quantum theory and the atomic theory of Bohr. Both M. le Duc de Broglie and Prof. R. Whiddington, who described the experiments, have recently been working on the same subject, namely, the properties of the electrons ejected from metallic atoms by the incidence of X-rays; and their results are in general agreement. The method of procedure has been to allow a beam of characteristic X-rays of known frequency, for example from a tungsten anticathode, to fall upon a prepared metallic surface, say of silver. The electrons which, as a consequence, emerge from the silver do not all possess, as Barkla at first supposed, equal amounts of energy. They thus have different velocities, and, by the well-known method of the application of a suitable magnetic field, the original mixed bundle of electrons can be differentially deflected, and spread out into a "magnetic spectrum." A focussing device is employed whereby the electrons of the same speed are concentrated upon the same part of the photographic plate, so that each line in the spectrum corresponds to a group of electrons having a definite velocity. There is a certain amount of general fogging of the plate, but the comparatively sharp lines superimposed are unmistakable. Several actual plates were shown both by M. de Broglie and Prof. Whiddington.

The interpretation of these spectra, which are of somewhat simple appearance, proves to be most important in relation to current theories of quanta and atomic structure. In the first place, the phenomenon obeys the general law of photo-electric effects, in that the velocity, and therefore the energy, of the electrons expelled depends only on the frequency, and not on the intensity, of the exciting X-radiation.

Of still greater importance is the bearing of the experimental results on Bohr's theory of atomic constitution. As is well known, this theory involves that the electrons, in number N, which surround the nucleus of an atom of atomic number N, are distributed in a certain number of regions, or layers, each characterised by the work which it is necessary to expend in order to remove an electron from the region under consideration, and bring it to the exterior of the atom. If we denote by the letters K, L, M, etc., the levels of these regions, we can attribute to them energies of extraction W_K, W_L, W_M, etc. The fundamental principle underlying the production of the magnetic spectra above mentioned will be made clear by quoting from M. de Broglie's remarks:

"What appears to happen is that if radiation of frequency ν strikes one of these electrons, situated, for example, in the region K, it communicates energy equal to $h\nu$ in order to extract the electron from the atom; it is clear that the corpuscle, once removed from the atomic edifice, will possess a resultant energy equal to $h\nu - W_K$."

In this, of course, h is Planck's constant, and the resultant energy of the electron, which proves to have the value specified, is that which is measured experimentally by means of the magnetic deflection. For truly monochromatic X-radiation, the magnetic spectrum would thus consist of a few lines, corresponding to the various different regions in the atom from which electrons may be ejected, *i.e.* to the various possible values of W. Unless $h\nu$ is greater than W the radiation is incapable of extracting electrons from the atomic region in question. This proves to be true experimentally; unless an anticathode is used for which the frequency of the characteristic radiation is sufficiently large in relation to at least some of the energies of electron extraction for the irradiated metal, no magnetic spectrum appears. With a Coolidge tube as the source of X-rays it has not been possible to make $h\nu$ large enough to extract the more deep-seated electrons in metallic atoms of high atomic number; but the employment of γ-rays, with their much greater frequency, has enabled Ellis to extend the process to these regions, and to prove in this case also the validity of the general relation.

The lines in the magnetic spectra are usually composite. This arises from the fact that the X-rays used are seldom monochromatic, the characteristic radiation from the anticathode having several components. Again quoting M. de Broglie:

"Each line of the spectrum of the incident X-rays re-echoes on each level of the illuminated atom in such a way that we obtain at once an analysis both of the spectral lines of the illuminating beam and of the Bohr levels of the illuminated atom."

The method, as M. de Broglie pointed out, serves for measuring, without the intervention of a crystal, the frequency and wave-length of X-radiation. It thus furnishes a means of checking the magnitudes of the crystal spacings which form the basis of X-ray analysis.

The papers of M. de Broglie and Prof. Whiddington evoked great interest in the Section. There was some discussion, particularly with reference to the general fogging of the magnetic spectrum plates, which seemed to point to some of the ejected electrons having all sorts of emergent velocities. Prof. Lindeman suggested the possibility of having to assume that in the atom there were numerous electron levels, instead of the comparatively small number assumed by Bohr. Sir Ernest Rutherford, however, was satisfied that no such explanation was needed, for the reason that the fogging was inevitable, owing partly to the general radiation from the anticathode, and partly to the fact that some of the ejected electrons would lose random amounts of energy from various causes along their paths to the photographic plate.

A. O. RANKINE.

Correlation of the Social Sciences.

A CONFERENCE was held at Oxford on October 7-9, under the auspices of the Sociological Society, with the view of securing proper correlation between the various sciences contributory to the science of sociology. Dr. A. J. Carlyle, of University College, Oxford, acted as local secretary, and other Oxford men, such as Prof. J. L. Myres and Dr. R. R. Marett, helped in the work of organisation. The Warden of New College gave the opening address. History, geography, biology, psychology, philosophy, anthropology, economics, and political science—all these subjects were considered, the reading of a paper on each being followed by a discussion.

Mr. J. S. Marvin emphasised the need for a constant return of the sociologist to history; in history we saw sociological principles in action. He pointed the difference between the two methods by showing how the biography of a great man like Napoleon, say, could be material for history or for sociology, according to the way in which it was treated. Sir Halford Mackinder (in contradistinction to some of the other speakers) made very modest claims for geography, merely pointing out that it was a limiting factor in sociological matters. Mr. J. S. Huxley attempted to show the principles which are common to human and non-human biology. He stressed the biological differences between man and other organisms as against the resemblances, and rebutted the claims of those who seek to make the struggle for existence the most important biological principle. Further, he pointed out that the general direction observable in organic evolution provided an objective criterion for ideas of progress in social science. Prof. Myres was emphatic on the need for a biological basis for any true science of sociology.

Dr. Marett read a very stimulating paper on anthropology, laying stress on the fact that anthropologists were now coming more and more to adopt what might be called sociological methods, in that they were investigating whole cultures instead of isolated actions or beliefs. He made it clear that the only essential distinction between anthropology and sociology to-day is that the former investigated primitive peoples, while the latter is concerned with the greater complexity of civilisation.

Prof. Spearman made large claims on behalf of psychology, and drew a vivid (if somewhat unpleasing) picture of a future state of society in which the ability of every boy and girl would be gauged, and their occupations found for them by the application of mental tests. This would bring about a state of affairs in which the just claims of democracy would be realised, together with the merits of aristocracy.

Prof. Leonard Hobhouse, in an attempt to lead the conference back to fundamentals, insisted that the primary difference between science and philosophy was that the latter introduced the idea of values—a statement which provoked an interesting discussion.

Prof. W. J. Roberts, in discussing economics, pointed out that a broad treatment of the subject was necessary, particularly in order to prevent the common mistake of students of regarding the existing state of affairs as approximately ideal. Historical and sociological aspects of the science should be stressed.

Finally, Dr. Carlyle, in a characteristically amusing and vigorous address, dealt with political science.

The conference was obviously a success, in that it stimulated thought and discussion, and was profitable to those who took part in it. But the subjects treated were so large, the modes of treatment so varied, that many were doubtful whether much advance had been made by its close along the path of correlation.

Mr. Graham Wallas, in opening one of the debates in his most refreshing manner, made a suggestion which may prove fruitful. He pointed out that those who presented papers were given much too free a hand—that they could say what they liked, and that, as a matter of fact, this was usually not what the sociologists wanted to know. He suggested that sociologists should draw up *questionnaires* asking for answers on certain definite points from the anthropologists, the psychologists, the biologists, and the rest.

It is clear that sociology can become a most important science, and that its field is one left severely alone by other sciences. But it has to accept the data of a great many special sciences, to take them on trust, and then to correlate them in a particular way. It is to be hoped that the Sociological Society will adopt some such plan as that of Mr. Wallas, pinning the experts down to answering certain problems on which it must have light. This might be done at next year's conference; and the year after another might be held to deal with the purely sociological task of synthesising and employing these data.

The Effect of Deformation on the Ar 1 Change in Steels.

THERE is considerable evidence as to the existence of lag in the crystallisation of pearlite, particularly in hypoeutectoid steels. Cooling curves show it in the observed temperature of the change, which depends on the rate of cooling. Microscopical observations testify to it in that the presence of carbide nuclei within the austenite (gamma iron) areas leads to crystallisation of globular pearlite at a temperature considerably higher than that at which growth occurs in the absence of such nuclei. Moreover, the growth of lamellar pearlite when once started does not occur simultaneously throughout the specimens. The change proceeds gradually, and there is no difficulty in quenching a specimen so that it contains areas both of pearlite (transformed) and martensite (partially transformed) intermixed.

In taking cooling curves, the specimen is usually allowed to cool undisturbed, and Mr. J. H. Whiteley has conducted an investigation to test whether the temperature of the change could be raised and the rate of pearlite growth increased by deforming steels in this metastable zone. Recently A. F. Hallimond, in discussing the question of delayed crystallisation, remarked that for super-saturated solid solutions, violent mechanical working may be the analogue of agitation. In Mr. Whiteley's experiments, described before a recent meeting of the Iron and Steel Institute, two methods of deformation were used, namely, hammering and bending. Tests were carried out in a small, electrically heated, vertical furnace, resting on a block of steel. A bar of hard chromium steel was used as an anvil, separated from the steel block by a thick pad of asbestos. Temperatures at the surface were measured. A rod of manganese steel selected because it is non-magnetic was used to transmit the hammer blows to the specimen on the anvil. In

carrying out the deformation by hammering, two small specimens, each weighing about one gram, were used. The temperature was raised to 900° C. and then lowered in about ten minutes to 695° C. After fifteen minutes the manganese steel rod was carefully placed on one of them, and a smart blow given with a hammer. To neutralise the effect of any slight difference in temperature between the end of the rod and the pieces, the rod was also placed on the other, but no blow was given. The positions of the two pieces were then interchanged. After an interval of ten minutes, the temperature still being 695° C., the above procedure was repeated in varying order about six times, and after a further five minutes the specimens were quenched in water. The deformations produced were comparatively small, not exceeding $\frac{1}{16}$ of an inch. Repeated experiments all agreed in showing that the lag at Ar 1 was diminished by this slight deformation. The author shows two photomicrographs. In one of these (the hammered specimen) fully half the austenite areas have been converted into pearlite. In the other (an unhammered piece) only one such area has undergone a change.

The same apparatus was used in the deformation by bending experiments. A V-shaped notch, $\frac{1}{8}$ of an inch deep, was cut in the top of the anvil, and the end of the manganese steel rod was shaped like a chisel. The metal used was a mild steel strip $\frac{1}{2}$ in. $\times \frac{3}{16}$ in. $\times \frac{1}{16}$. This was placed across the notch, heated to 900° C. and cooled to 695° C. After fifteen minutes the rod was placed upon it so that the end was in line with the notch, and two or three light blows were given with the hammer. In this way the strip was bent to an angle of about 60°. After a further five minutes at 695° C. the strip was taken out and quenched. This experiment was made repeatedly, always with the same result. At the bend, as shown in the author's photomicrograph, pearlite was always present, but in the limbs where the metal had not been distorted, the structure consisted almost entirely of ferrite and martensite. A similar but less pronounced effect was produced when strips were bent while being maintained at a temperature of 700° C.

The author states in conclusion that although lag was reduced, it was not completely eliminated by the methods of deformation used, since, in a previous investigation with the same steel, globular pearlite was found to grow between 705° and 708° C. when carbide nuclei were present in the austenite. Both hammering and bending tests, however, agree in showing that the lag at Ar 1 can be appreciably diminished through deformation.

Medical Education.

THE professional course has grown so full in the training of a medical student that it has become increasingly difficult to cover the ground and secure qualification in a reasonable time. Some years ago this fact raised in an acute form the position of the preliminary examinations in the pure sciences. If these examinations were abolished, or placed outside the professional course, obviously a gain in time would result for abler students. The best account of the matter is to be found in the appendix to the fifth report of the Royal Commission on University Education in London—especially under the evidence of Sir H. Morris, Mr. Flexner, and others. The practice in other countries in regard to the preliminary sciences is also clearly described.

The new regulations of the General Medical Council in regard to student registration presumably indicate the conclusions of that body on the problem. The preliminary sciences are retained, but two of them are placed outside the professional course; at the same time the age of student registration is raised to seventeen years. The examinations in chemistry and physics must be passed *before* registration but *after* the examination in general education. Biology may not be taken until after registration.

The examinations in these preliminary sciences must be conducted or recognised by one of the existing licensing bodies. It remains to be seen what provision the licensing bodies will make for these pre-registration examinations. The Conjoint Board has not yet issued its regulations. Student registration is, of course, at present not legally obligatory, but the older licensing bodies, such as the Universities of Oxford and Cambridge, usually conform so far as possible to the requirements of the General Medical Council. It is at present unlikely that either Oxford or Cambridge will alter its current practice. Each will continue to conduct its present preliminary examinations and postpone student registration until after they have been passed.

These examinations can all of them now be taken under certain conditions before residence is begun. This comparatively recent concession on the part of these universities leaves their candidates practically unaffected by the new General Medical Council regulations. Boys going to these universities will postpone registration until after passing the preliminary examinations instead of, as at present, registering when they have passed the general education examination. It is not unlikely, however, that both Oxford and Cambridge may extend recognition to biology in their own Higher Certificate examinations—they will inevitably do so some day. This would prevent a hardship which may occur at present to a boy who can only proceed to the university if he wins a scholarship. The university scholarships are open up to nineteen years of age. If a boy waits for these and is unsuccessful, he would have obtained his qualification more quickly by leaving school at seventeen years of age and proceeding straight to a hospital. If he is allowed a certificate for all the preliminary sciences on the Higher Certificate examination, such a boy would lose less time.

The Chilian Earthquake.

FROM the first accounts which have reached this country, it is evident that one of the world's greatest earthquakes occurred shortly before midnight on November 10-11 off the coast of Chile. As in all such earthquakes, the duration of the shock was considerable—nearly three minutes at Valparaiso and four minutes at Caldera—but it should be remembered that such estimates may include some of the immediately succeeding after-shocks. There can be no doubt, however, as to the great extent of the disturbed area. Along the coast, the shock was felt from Antofagasta to Valdivia, a distance of 1100 miles. It was felt across the continent at Buenos Ayres, where it was strong enough to stop clocks. As this city is about 900 miles from Coquimbo (which appears to be near the epicentre), the disturbed area must contain more than $2\frac{1}{2}$ million square miles. The shock is also said to have been felt at Hilo, in Hawaii, but, without further and much stronger evidence, the statement may be discredited. The district over

which houses were damaged was also large, though perhaps not unusually large. The zone most affected was that between Coquimbo and Chanaral, the latter place being nearly 100 miles north of Coquimbo, but houses were also slightly damaged at Valparaiso, which lies about 240 miles to the south.

In this earthquake, as in so many others on the western coast of America, it is difficult in the early accounts to separate the effects of the shock from those produced by the sea-waves and by the fires that followed the earthquake. The sea-waves were observed along the coast from at least Antofagasta on the north to Talcahuano (near Concepcion) on the south, a distance of nearly a thousand miles. They were large enough to wash away boats at Hilo in Hawaii. All the submarine cables along the coast appear to be broken, but the statement that soundings taken between Copiapo and Caldera gave a depth of 86 fathoms, instead of 2800 fathoms as marked on the chart, must of course be erroneous. The earthquake resembles its predecessors in its submarine origin some distance from the coast.

University and Educational Intelligence.

BIRMINGHAM.—The following appointments have been made by the Council: Mr. A. W. Nash, lecturer in oil mining; Dr. E. Ashley Cooper, lecturer in public health chemistry; and Mr. D. R. Nanji, assistant lecturer and demonstrator in the department of brewing and the biochemistry of fermentation.

CAMBRIDGE.—Mr. G. C. Steward has been elected to a fellowship at Gonville and Caius College, and Mr. G. Udny Yule, Mr. J. E. P. Wagstaff, and Mr. W. M. H. Greaves to fellowships at St. John's College.

LONDON.—The Senate invites applications for a new University Chair of Anatomy tenable at St. Bartholomew's Hospital Medical College, which has not hitherto had a professor of the subject attached to it. The present University professors of anatomy are as follows: Prof. E. Barclay-Smith, King's College; Prof. J. E. S. Frazer, St. Mary's; Prof. T. B. Johnston, Guy's; Prof. F. G. Parsons, St. Thomas's; Prof. G. Elliot Smith, University College; Prof. W. Wright, London; and Prof. T. Yeates, Middlesex. The full title of the holder of the chair at St. Bartholomew's will be "Professor of Anatomy in the University of London." The appointment will date from September 1, 1923, and will be subject to the statutes and regulations of the University and to the regulations of St. Bartholomew's Hospital Medical College. The professor will be expected to devote his whole time to the duties of the chair, except that he may be permitted to hold examinerships in anatomy, and will be able to devote time to research. The salary of the chair will be 1000*l.* per annum. Arrangements for assistance and for departmental expenditure are made by the Medical College of St. Bartholomew's Hospital in consultation with the professor. Applications for the chair (12 copies) must be received not later than first post on April 16, 1923, by the Academic Registrar, University of London, South Kensington, London, S.W.7, from whom further particulars may be obtained.

ST. ANDREWS.—Mr. Rudyard Kipling has been elected Rector in succession to Sir James M. Barrie.

SHEFFIELD.—Mr. R. Stoneley, assistant lecturer in mathematics, has been appointed curator of the University Observatory.

PROF. ALFRED TENNYSON DELURY, head of the department of mathematics, University of Toronto, was in June last appointed Dean of the Faculty of Arts of that University. Sir Robert Falconer, president of the University, called a meeting of the Council of the Faculty of Arts and announced that, while the appointment of a Dean was by statute in his hands, he would like to receive nominations from the Council for an appointment to this important post. Nominations were accordingly made and balloting was carried on by mail.

THE first meeting of the Court of Governors of the University College of the South-West of England, Exeter, was held on October 27. The new governing body takes over the former Royal Albert Memorial College, Exeter, with its hostels and other property, and also enters into possession of the site and mansion-house given by Mr. W. H. Reed for the purposes of the new college buildings. The new University College which, on the recommendation of the University Grants Committee, has been placed upon the Treasury list of Universities and University Colleges as from August 1, 1922, is regarded as the first step towards the establishment of a University in the South-West of England. H.R.H. the Prince of Wales and Duke of Cornwall is president of the college, and sent a message of greeting and good wishes on the occasion of the first meeting of the court. The court elected Sir Henry Lopes, Bart., as deputy-president of the college: and one of the vice-presidents is Sir Arthur Quiller-Couch. The deputy-president made a statement to the court as to the present position and prospects of the college, emphasising his view that the governing principle of college policy should be the attainment, as soon as possible, of a status which would free the college from a purely external degree system, and indicating the possibilities of co-operation to this end among the various higher educational institutions in the south-western countries. A very substantial increase in the number of full-time degree students in attendance at the college was reported.

ON the occasion of the transfer of the Imperial Department of Agriculture from Barbados to Trinidad, following upon its amalgamation with the West Indian Agricultural College, Sir Francis Watts, principal of the College and Commissioner of Agriculture, received a letter from the Acting Governor of Barbados in which the latter stated that the department's work "has been a landmark in the history of the West Indian Colonies." He continued, "I beg also to be allowed to express the cordial gratitude of the Government of Barbados for the valuable and ready assistance which the Imperial Department has rendered the local Government on numerous occasions . . . may I also assure you of the warm good wishes of the Barbados Government for the success and prosperity of the Agricultural College in which the Department will now be merged, and of our confident hope that the establishment of the College will prove to be a great step forward in the development of scientific tropical agriculture not only in the West Indies but also in a wider field."

THE Royal Technical College, Glasgow, publishes for the session 1922–23, in a calendar comprising 356 closely printed pages, a vast amount of information relating not only to the courses of instruction it offers, the conditions under which the diplomas and degrees for which it prepares are obtainable, and the scholarships tenable in it, but also to the appointments now held by its past students. The list of past students and their appointments, including nearly a thousand names, affords convincing evidence of the practical value of the instruction given, and should be of great interest alike to past, present, and prospective students.

Calendar of Industrial Pioneers.

November 19, 1883. Sir William Siemens died.—One of four brothers who were all closely associated with the application of science and the management of great industrial concerns, Siemens was born in Lenthe, Hanover, on April 4, 1823. He settled in England in 1844 and in 1859 became a naturalised British citizen. His name is connected with the introduction of the regenerative furnace for steel-making and the enunciation of the principle of the modern dynamo. He designed the cable ship *Faraday*, and was president of various technical institutions.

November 20, 1713. Thomas Tompion died.—The father of English watch-making, Tompion began his apprenticeship in London in 1664 and by 1675 had gained a foremost place among his fellow mechanicians. He supplied the first clocks to the Greenwich Observatory, and under Hooke's direction made one of the first English watches with a balance spring. His work made English watches the finest in the world. He is buried in the nave of Westminster Abbey, in the same grave as his famous pupil and successor, George Graham.

November 20, 1898. Sir John Fowler died.—A great railway engineer, and jointly responsible with Baker for the design of the Forth Bridge, Fowler's early work was done in the Sheffield district, while he afterwards became engineer to the Metropolitan Railway.

November 21, 1555. Georg Agricola died.—Agricola has been called the Bessemer of his age. He was born in Saxony in 1494, studied medicine at Leipzig and in Italy, and practised in Bohemia. Subsequently he abandoned his profession, became absorbed at Chemnitz in the study of metals and mining, and was given a pension by the Duke of Saxony. He collected specimens of ores, studied their chemical characters, and described them accurately. His work, "De re Metallica," is considered the most important technical book of the sixteenth century.

November 21, 1863. Samuel Hall died.—A native of Basford, Nottingham, Hall made a considerable fortune by his invention of a method of gassing lace and net. In 1836 he took out a patent for a surface condenser for ships which embodied most of the features of condensers as in general use to-day.

November 23, 1902. Sir William Chandler Roberts-Austen died.—The successor of Graham as chemist to the Mint, Roberts-Austen did much valuable work on the study of alloys, and was regarded as an authority on all that appertains to coinage. He delivered many important lectures, and in 1899–1900 served as President of the Iron and Steel Institute.

November 24, 1916. Sir Hiram Stevens Maxim died.—One of the greatest inventors of the nineteenth century and a pioneer worker on the flying machine, Maxim, like Edison and Swan, assisted to introduce the electric light, and then, turning his attention to the construction of an automatic gun, brought out his Maxim gun, which ever since has played so important a part in all warfare. He was also the first to combine nitroglycerine and true gun-cotton in a smokeless powder.

November 25, 1893. Johann Bauschinger.—A distinguished investigator of the strength of materials and the founder of the International Association for Testing Materials, Bauschinger was born in Nuremberg in 1834, and for twenty-five years was professor of mechanics and graphic statics at the Technical High School at Munich.

E. C. S.

Societies and Academies.

LONDON.

Royal Society, November 9.—Sir Charles Sherrington, president, in the chair.—**H. E. Armstrong**: Studies on enzyme action. XXIII. Homo- and hetero-lytic enzymes.—**A. V. Hill** and **W. E. L. Brown**: The oxygen-dissociation curve of blood and its thermodynamical basis. An attempt has been made to test the validity of the hypotheses (i) that the reaction of hæmoglobin with oxygen is represented by the equation $(Hb)_n + nO_2 \rightleftharpoons (HbO_2)_n$, where Hb represents the simplest possible molecule of hæmoglobin (containing one atom of iron), and n the average degree of polymerisation of the molecule in the presence of the salts in blood: and (ii) that the dissociation curves of oxyhæmoglobin under various conditions can be deduced by simple application of the Laws of Mass Action. The heat of reaction q of one gm. mol. of hæmoglobin $(Hb)_n$, with oxygen has been determined by the application of the van't Hoff isochore to the effect of temperature on the dissociation curve of blood, while the heat of reaction Q of one gm. mol. of oxygen with hæmoglobin has been measured directly in a calorimeter. The value of q/Q is practically equal to n determined in other ways, affording strong confirmation of hypothesis (1). The apparent heat of reaction of oxygen with blood may be very considerably reduced by the driving off of carbon dioxide by the more acid oxyhæmoglobin formed. A direct measurement of the heat of combination of carbon dioxide with blood confirms the theory that carbon dioxide combines with blood by taking base from the ionised hæmoglobin salt to form bicarbonate, leaving the non-ionised hæmoglobin acid. The heat of combination of carbon monoxide with hæmoglobin in blood is about 50 per cent. greater than that of oxygen: this proves that temperature affects the equilibrium of oxygen and carbon monoxide with blood.—**H. Hartridge** and **F. J. W. Roughton**: The velocity with which carbon monoxide displaces oxygen from its combination with hæmoglobin. Pt. I. When light falls on a solution containing oxyhæmoglobin and carbon monoxide hæmoglobin, the incoming light energy changes the position of equilibrium, tending to cause a reduction in the amount of the latter with a corresponding increase of the former. In the dark the original position of equilibrium is gradually recovered, the rate of return depending on the velocity constants of the reactions. By determining the percentage saturation of the hæmoglobin with carbon monoxide gas at intervals after the light has been turned off, the velocity constants can be calculated. This is done by causing the fluid to flow through two glass tubes in series; in the first it is exposed to a powerful light, while in the second it is kept in the dark, so that the original position of equilibrium is gradually regained. The percentage saturation with carbon monoxide gas of the solution at different parts of the "dark" tube was determined with the reversion spectroscope. At 15° C. the two velocity constants had mean values of 0·0067 and 0·55 respectively. At 34·5° C. the value of K_2 was 2·66, which gives a temperature coefficient for this velocity constant of 2·3 for a 10° C. rise of temperature,—approximately that given by many ordinary chemical reactions. Pt. II. The method of measuring the velocity of the reaction $CO + O_2Hb \rightleftharpoons COHb + O_2$ consists in ascertaining, by means of an electrically controlled stop-watch, the time taken for the equilibrium to shift from an unstable position to a stable one, the change being ascertained by

measurements on the absorption bands by means of the reversion spectroscope. The system was changed to an unstable position by (1) subjecting the solution to the action of a powerful beam of light, and by (2) suddenly obstructing the light rays. Thus chance fluctuations in the catalysing light source, and in the flow of the liquid under observation were avoided, but it was difficult to make accurate estimations on absorption bands moving from one position in the spectrum to another. Observations of the equilibrium constant were made by method (1) at 1° C. and laboratory temperature, and by method (2) at laboratory temperature and 34° C. At laboratory temperature, method (1) gave 0·51 and 0·59, and method (2) 0·44 and 0·40. The temperature coefficient per 10° C. calculated from values obtained by method (1) was 2·3, while method (2) gave 2·5 and 2·7.—L. T. **Hogben**: Studies on internal secretion. I. The effect of pituitary (anterior lobe) injection upon normal and thyroid-ectomised axolotls. While pituitary feeding has no influence on the metamorphosis of medium-sized or sexually mature axolotl larvæ of *Amblystoma tigrinum*, injection of anterior lobe extracts into axolotls of the same ages and dimensions was followed by the assumption of the adult characteristics, with rapidity comparable to metamorphosis induced by thyroid administration, and beginning about two to three weeks after the initial injection. Anterior lobe extracts also induce metamorphosis in thyroidless larvæ. Spontaneous metamorphosis does not generally occur, as Marie de Chauvin stated, in larvæ of six to nine months when placed in shallow water with opportunities for emerging.—L. T. **Hogben** and F. R. **Winton**: The pigmentary effector system. II. Apart from caffeine, the only reagents found to induce melanophore contraction were those known to excite peripheral sympathetic nerve-endings, namely, adrenalin, tyramine, ergotoxine, and cocaine. Apart from pituitary extract, the only reagents found to bring about melanophore expansion were apocodeine and nicotine, in quantities sufficient to paralyse all sympathetic nerve-endings. No unequivocal direct evidence is advanced that nervous control of pigment responses in Amphibia has been found. Synchronous colour changes of Amphibia in response to normal environmental stimuli are possibly determined mainly by endocrine influences.—A. **Fleming** and V. D. **Allison**: Further observations on a bacteriolytic element found in tissues and secretions. Strains of *M. lysodeikticus* resistant to lysozyme action can readily be developed. The resistance is not specific, *i.e.* strains made resistant to one tissue or secretion are equally resistant to all tissues, whether derived from man, the lower animals, or from vegetables, showing that the lysozyme affecting *M. lysodeikticus* is the same whatever tissue it is derived from. After solution of a large number of *M. lysodeikticus* there is an increase in the lytic power of the fluid, which affects wholly or mainly the homologous microbe. Different tissues and secretions vary in their capacity to dissolve different bacteria, and some tissue extracts have a marked lytic action on many of the well-known pathogenic bacteria.

PARIS.

Academy of Sciences, October 23.—M. Albin Haller in the chair.—Ch. **Barrois**, P. **Bertrand**, and P. **Pruvost**: Observations on the coal measures of the Moselle.—W. **Kilian**: The stages of the retreat of alpine glaciers and the origin of Lake Lauvitel (Oisans).—A. **Angelesco**: A functional property of conics.—E. **Merlin**: Some properties of networks.—M. **Desaint**: The general representations of analytical functions.—P. J. **Myrberg**: The singularities of automorphic functions.—Frithiof **Nevanlinna**: The relations which exist between the distribution of the zeros and the poles of a monogen function and the increase of its modulus.—Alf. **Guldberg**: A theorem of M. Markoff.—Constant **Lurquin**: The criterium of Tchebycheff.—MM. **Constantin, Joessel**, and **Daloz**: A boat which moves against the wind using the wind itself as motive power. The motor is an air turbine of 9 metres diameter connected with a screw propeller by gearing. No drawings or details are given, but it is stated that a small 6-ton fishing-boat fitted with the motor has given successful results on trial.—L. de **Broglie** and A. **Dauvillier**: The spectral system of the X-rays. The proposed system is based on the principle of rigorous alternation of regular and irregular doublets (Wentzel), following the views of Smekal and of Rubinovicz. The table given includes some lines predicted from the theory but not yet observed.—M. **Vuillaume** and A. **Boutaric**: The photometry of sources of light constituted by black bodies at different temperatures.—R. **Mesny**: The generation of polyphase oscillations of high frequency by electronic tubes.—André **Charriou**: The separation of ferric oxide and alumina from magnesia by the method of nitrates.—M. **Picon**: The action of sodammonium on hexamethylenetetramine, tetramethyldiaminomethane, and ethylideneethylimine. Sodammonium, in liquid ammonia, is without action on hexamethylenetetramine at the ordinary temperature. The imine $CH_3 . CH : N . C_2H_5$, derived from acetaldehyde and ethylamine, is attacked by sodammonium giving diethyldiaminobutane.—**Pereira de Sousa**: The basic rocks of the nepheline syenite massif of the "Serra de Monchique."—Paul **Lemoine** and A. **Pinard**: The mode of contact of the chalk and pisolithic limestone at Meulan-Gaillon (Seine-et-Oise). The limestone has filled irregular pockets in the chalk, and a section of one such pocket is given.—Mlle. F. **Brepson**: The rôle of the phenomena of solifluxion in the model of the region of Saulieu (Morvan). The formation of ponds and lakes in this district cannot be explained as being due to the erosion of streams, nor is there any evidence of glacial action, and it is suggested that earth slides may have been the cause of this formation. The products of granite disintegration imbibe water freely and have a tendency to slip down the steep slopes, forming ridges known as *rideaux*. Examples of these phenomena in the neighbourhood of Saulieu are given, and this is considered to afford an explanation of the large number of small lakes in the district.—J. **Lacoste**: New radiogoniometric observations of atmospherics. An application of wireless telegraphy to the prediction of storms.—René **Souèges**: The embryogeny of the Caryophyllaceæ. The first stages in the development of the embryo of *Sagina procumbens*.—Marcel **Mirande**: The relation existing between the relative acidity of the tissues and the presence of anthocyanine in the scales of lily bulbs exposed to light.—André **Guillaume**: Study of the limits of vegetation in the north and east of France. A study of the conditions limiting certain plants to certain areas. Meteorological, geological, physical, and palæontological influences are discussed, the effect of climate being the most important.—Med. **Gard**: The withering of young walnut trees in 1922. In the spring of this year there were heavy losses in young walnut trees. This does not appear to have been due to disease, as was at first suspected, but is attributed by the author to autumnal frosts.—G. **Vernet**: The rôle of calcium chloride in the coagulation of the latex of *Hevea Brasiliensis*. The addition of solutions of calcium

chloride to the latex of Hevea increases the rapidity of the coagulation and also the total weight of rubber obtained. The causes of these results are discussed.—Émile F. **Terroine** and H. **Barthélemy**: Avitaminosis and inanition. Two views of the action of vitamins have been put forward, one regarding these substances as indispensable for nutrition, the other as affecting the secreting power of glands and the diastatic properties of the digestive juices. According to the latter view, the nerve troubles and death resulting from feeding on polished rice are due to starvation caused by the inability of the intestine to assimilate the food. The authors use as a test for death by starvation the percentage of fats and lipoid substances in the animal, and find that in cases of avitaminosis neither the nerve troubles nor death can be wholly attributable to inanition.—M. **Marage**: Phonation and telephonic audition. The author's results are in agreement with those of Fletcher, although the methods employed are absolutely different.—A. **Policard**: The working of the adipose tissue. Researches on the nuchal gland of rodents.—M. **Vila**: Separation of the globulins of horse serum. The globulins are removed from the diluted serum by treatment with three volumes of cooled acetone, and these can be separated into fractions by treatment with dilute hydrochloric acid.—Y. **Manouelian** and Jules **Viala**: A case of hydrophobia in a lioness.—René **Zivy**: An unpublished method of preparing vaccine. Sterilisation is produced by repeated freezing at $-18°$ C. and thawing. Pneumococcus was the most readily sterilised (two freezings), while enterococcus, the most resistant, required six.—Marcel **Leger** and A. **Baury**: Healthy carriers of the plague bacillus. A proof that negroes in Senegal, quite free from any clinical signs of plague, carried the Yersin bacillus and could act as plague carriers.

SHEFFIELD.

Society of Glass Technology (York Meeting), October 18.—Prof. W. E. S. Turner, president, in the chair.—J. A. **Knowles**: Processes and methods of medieval glass painting. Medieval window glass differs from modern glass in that whereas the ancient material was a potassium-calcium-silicate, modern glass is a soda-lime glass. The northern school of glass-painting situated at York in the middle ages obtained glass from the northern Continental glass-making districts of Hesse and other Rhenish provinces. The London school drew it from Lorraine, Burgundy, and Normandy. The uncoloured glass used in the north was much whiter than that employed in the south, probably due to the use of English-made white glass from the works at Chiddingfold. The present-day glass maker can produce colours with a certainty and in a far greater range of tints than the medieval craftsmen could. With the exception of the red or "ruby" glass, the medieval coloured glasses were those which were most easily produced. Being made from native oxides which contained other metals as impurities, the resulting colours were not pure or always harmonised. The colours such as red, blue, and green were contained in the glass itself, but details such as the face, folds of drapery, and ornamental work were painted on with a brown vitrifiable pigment, formed of a metallic oxide such as red oxide of iron or black oxide of copper, mixed with a soft glass known as "flux." In the kiln the flux melted before the glass itself, and attached the black oxide to the surface.—H. J. **Powell**: Modern developments in the making of stained and painted glass. The substance of much medieval window glass decays though many pieces of ancient Roman glass are sound. Some medieval glass has become partly or wholly opaque, and crumbles to powder. The most defective glass belongs to the fourteenth century. All the forms of decay originate from the excessive proportion of alkali in the glass mixture which causes the glass to be hygroscopic.

WASHINGTON, D.C.

National Academy of Sciences (Proc., Vol. 8, No. 10, October 1922).—H. **Blumberg**: New properties of all real functions. Descriptive and metric properties of planar sets and real single-valued functions of two real variables, with some generalisations, are discussed.—C. N. **Moore**: Generalised limits in general analysis. A proof is given of a generalisation of a theorem in the theory of divergent series.—Martha **Bunting**: Preliminary note on Tetramitus, a stage in the life cycle of a coprozoic amœba. Coprozoic amœbæ in cæcal material from a rat were cultivated on an artificial medium. Amœbæ containing at least one large contractile vacuole emerge from cysts, commonly spherical, the walls of which apparently dissolve. Prior to division, the amœba becomes homogeneously refractive ("gel" state). After division, individuals may become amœbæ or develop flagellæ. The flagellate form is thought to be identical with *Tetramitus nostratus* Perty; it reproduces by longitudinal fission after passing through a "gel" state. Eventually the amœboid form is reassumed. Reproduction of both forms appears to be indefinite but the amœbæ finally encyst.—Raymond **Pearl** and T. J. **Le Blanc**: Further note on the age index of a population. The numerical index of the age distribution of a population previously proposed by Pearl has been used successfully employing six to eight age groups covering the life span. Statistics from the 1915 census of Iowa show that it is also trustworthy, using only three age groups; there is high correlation between the values of the index for coarse and fine age groupings.—A. A. **Noyes** and H. A. **Wilson**: Thermal ionisation of gaseous elements at high temperatures; a confirmation of the Saha theory. It has been shown that the conductivity of flames into which salt solutions are sprayed is (*a*) independent of the acidic constituent of the salt; and (*b*) changes with the concentration of the salt in accordance with the equilibrium constant obtained when the substance, its ions and electrons, as represented by the equation $M = M^+ + E^-$, are regarded as perfect gases. Substantially, the whole conductivity is due to the electrons present. From (*b*) relative values for the ionisation constants of five alkali elements are calculated; the series is closely parallel to that obtained from thermodynamical equations utilising ionisation potentials as employed by Saha.—E. H. **Hall**: An electron theory of electric conduction in metals. It is assumed that an ion is formed from a metal atom by loss of an electron from the outer shell, leaving a pit in the ion which renders it unsymmetrical. An imposed electric field turns the ions so that the pits move as a positive charge would do, giving the effect of an electric current. Ohm's law can be justified, and an explanation is offered of the variation of metallic resistance with temperature. Rise of temperature probably directly increases resistance rapidly, while the increased number of ions produced tends to reduce it.—C. **Barus**: Static deflection, logarithmic decrement and first semi-period of the vacuum gravitation needle. These three quantities are similar time functions with a period of one day; they are largest in the morning and least at night. Static deflection and logarithmic decrement appear to be nearly proportional, while the latter and the first semi-period also form a definite curve.

Official Publications Received.

The Science Reports of the Tôhoku Imperial University, Sendai, Japan. Second Series (Geology), Vol. 7, No. 1: Notes on some Mesozoic Plants from Japan, Korea, and China, in the Collection of the Institute of Geology and Palæontology of the Tôhoku Imperial University. I. By H. Yabe. Pp. 28+4 plates. (Tokyo and Sendai: Maruzen Co. Ltd.)

Department of Agriculture. Report of the Director of Agriculture for 1921. Pp. 58. (Peradeniya, Ceylon.)

Ministerio da Agricultura, Industria e Commercio: Directoria de Meteorologia. Boletim Meteorologico: Anno de 1915. Pp. viii+137. (Rio de Janeiro.)

The South-Eastern Naturalist: Being the Twenty-seventh Volume of Transactions of the South-Eastern Union of Scientific Societies, including the Proceedings at the Twenty-seventh Annual Congress, held at Southampton, 1922. Edited by Edward A. Martin. Pp. lxiii +73. (London: 285 Holmesdale Road, S.E.25.) 5s. net.

Diary of Societies.

SATURDAY, NOVEMBER 18.

BRITISH MYCOLOGICAL SOCIETY (in Botany Department, University College), at 11.—Prof. A. Castellani: Mycology in Tropical Medicine. —Miss G. Gilchrist: Bark Canker Disease of Apple (*Myxosporium corticolum*).—Miss E. S. Moore: The Physiology of *Fusarium cæruleum*.—R. J. Tabor: A new fungal disease of Cacao and Coffee. —Dr. M. C. Rayner: The Mycorrhizal Fungus in relation to *Calluna* Cuttings.

MONDAY, NOVEMBER 20.

INSTITUTE OF ACTUARIES (at Royal Society of Arts), at 5.—W. P. Phelps: Presidential Inaugural Address.
ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge, Kensington Gore), at 5.—Capt. G. I. Finch: The Equipment for High Climbing.
INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—F. J. Pearce, and others: Discussion on Electric Light Wiring.
INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section), at 7.—H. R. Hockley: Works Management.
ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—L. M. Tye: Illuminating Engineering in relation to Architecture.
INSTITUTE OF BREWING, at 8.—W. A. Riley: Elimination of Waste.
CHEMICAL INDUSTRY CLUB (at 2 Whitehall Club), at 8.—O. F. C. Bromfield: The Merchant Traders' View on Government Control of Trade in connexion with the Safeguarding of Industries Act and the Dyestuffs (Import Regulation) Act.

TUESDAY, NOVEMBER 21.

ROYAL GEOGRAPHICAL SOCIETY AND THE ALPINE CLUB (at Central Hall, Westminster), at 3.—Capt. J. B. L. Noel: First Exhibition of the Mount Everest Expedition Kinematograph Film.
ROYAL SOCIETY OF MEDICINE, at 5.—General Meeting.
ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.—Lord Emmott: The Relations of Capital and Labour. (Inaugural Address.)
ZOOLOGICAL SOCIETY OF LONDON, at 5.30—The Secretary: Report on the Additions to the Society's Menagerie during the month of October, 1922.—I. G. S. Montagu: A further Collection of Mammals from the Inner Hebrides.—F. R. Wells: The Morphology and Development of the Chondocranium of the larval *Clupea harengus*.—R. I. Pocock: The External Characters of the Beaver (Castoridæ) and some squirrels (Sciuridæ).—A. Loveridge: Notes on East African Birds (chiefly nesting-habits and stomach-contents) collected 1915–1919.—E. A. Stensiö: Notes on certain Crossopterygians.—Dr. E. Ghosh: The Animal of *Scaphula* Benson, with the Description of a new Species of *Scaphula*.—J. H. Lloyd and Edith M. Sheppard: A Contribution to the Anatomy of a Hammerhead-Shark (*Zygæna malleus*).—R. H. Mehra: Two new Indian Species of the little-known Genus *Aulodrilus* (Bretscher), aquatic Oligochæta belonging to the Family Tubificidæ.—Dr. J. Stephenson: The Oligochæta of the Oxford University Spitsbergen Expedition.—R. J. Ortlepp: The Nematode Genus *Physaloptera*, Rud.—G. M. Vevers: The Cestode Parasites from Mammalian Hosts which died in the Gardens of the Zoological Society of London, during the Years 1919–1921; with a Description of a new Species of *Cyclorchida*.
INSTITUTION OF CIVIL ENGINEERS, at 6.—E. O. Forster-Brown: Underground Waters in the Kent Coalfield, and their incidence in Mining Development.
INSTITUTE OF MARINE ENGINEERS, INC., at 6.30.—G. J. Steinheil: The Evolution of the Nobel Diesel Engine (Part II.).
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—A. L. Coburn: Astrological Portraiture.
ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Miss M. A. Murray: Recent Excavations in Malta.
ROYAL GEOGRAPHICAL SOCIETY AND THE ALPINE CLUB (at Central Hall, Westminster), at 8.30.—Captain J. B. Noel: First Exhibition of the Mount Everest Expedition Kinematograph Film.
ROYAL SOCIETY OF MEDICINE (Pathology Section), at 8.30.—Dr. O. L. V. de Wesselow: The Calcium and Phosphorus of the Blood in Nephritis.—Dr. C. E. Dukes: A New Fermentation Tube.—Dr. A. J. Eagleton, Dr. C. C. Okell, and Miss E. M. Baxter: The Serological Classification of B. Diphtheriæ.

WEDNESDAY, NOVEMBER 22.

ROYAL SOCIETY OF MEDICINE, at 5.—Prof. H. C. Jacobaeus: The Practical Importance of Thoracoscopy, especially in the Pneumothorax treatment of Pulmonary Tuberculosis. (Occasional Lecture.)
ROYAL METEOROLOGICAL SOCIETY, at 5.—Sir Napier Shaw: An account of the work of the Meteorological Section of the International Union of Geodesy and Geophysics during the meeting at Rome in May, 1922.—A. H. R. Goldie: Circumstances determining the Distribution of Temperature in the Upper Air under conditions of High and Low Barometric Pressure.—Rev. J. Algué: The Manila Typhoon of May 23, 1922.
GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. A. S. Eddington: The Borderland of Astronomy and Geology.
ROYAL SOCIETY OF ARTS, at 8.—Bailie W. Smith: The Economy of Smoke Abatement.

THURSDAY, NOVEMBER 23.

MEDICO-PSYCHOLOGICAL ASSOCIATION OF GREAT BRITAIN (at the Bethlem Royal Hospital), at 2.45.—Prof. G. M. Robertson: The Discovery of General Paralysis, from Haslam to Bayle.—Dr. E. W. Scripture: The Treatment of General Paralysis by Malaria and the use of Speech Inscriptions for Early Diagnosis.
ROYAL SOCIETY, at 4.30.—*Probable Papers.*—Dr. T. E. Stanton: The Characteristics of Cylindrical Journal Lubrication at High Values of the Eccentricity.—Prof. F. C. Thompson and E. Whitehead: On the Changes in Iron and Steel at Temperatures below 280° C.—Dr. J. H. Jeans: The Propagation of Earthquake Waves.—Prof. F. A. Lindemann and G. M. B. Dobson: A Theory of Meteors and the Density and Temperature of the Outer Atmosphere to which it leads.—C. F. Jenkin: The Fatigue Failure of Metals.—Dr. S. Brodetsky: The Line of Action of the Resultant Pressure in Discontinuous Fluid Motion.—Dr. R. A. Houstoun: An Investigation of the Colour Vision of 527 Students by the Rayleigh Test.
CAMERA CLUB, at 8.15.—Dr. G. H. Rodman: The Story of the "Cuckoo Spit."

FRIDAY NOVEMBER 24.

MEDICAL OFFICERS OF SCHOOLS ASSOCIATION (at 11 Chandos Street, W.1), at 5.—Dr. A. R. Friel: The Ionisation Treatment of Otorrhœa.
ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section), at 5.
PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—E. G. Richardson: The Theory of the Singing Flame.—Prof. R. Ll. Jones: Vibration Galvanometers with Asymmetric Moving Systems.—Miss Alice Everett: Unit Surfaces.—P. Schilowsky: Demonstration of some Practical Applications of the Gyroscope.
INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Adjourned discussion on paper by W. Reavell: Air Compressors.
JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—F. E. Murrell: Notes on Waterworks Plant in India.
INSTITUTION OF PRODUCTION ENGINEERS (at Engineers' Club, Coventry Street, W.1), at 7.30.—G. Hey: Standardisation.
ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.—Dr. F. M. Turner: A Statistical Study of the Age Incidence of Scarlet Fever.—Dr. J. Brownlee: A Note on the Relation between Rainfall and Scarlet Fever.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 8.—C. H. E. West: The Fascination of North Africa.

SATURDAY, NOVEMBER 25.

ASSOCIATION OF SCIENCE TEACHERS AND THE ASSOCIATION OF UNIVERSITY WOMEN TEACHERS (at University College), at 11 and 2.30. —Joint Conference on the Teaching of Science in Schools and Colleges.

PUBLIC LECTURES.

SATURDAY, NOVEMBER 18.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—A. D. Howell Smith: Textiles and their History.

MONDAY, NOVEMBER 20.

ROYAL SANITARY INSTITUTE, at 4.—Dr. A. Balfour: The Sanitary Inspector in the Tropics.
CITY OF LONDON Y.M.C.A. (186 Aldersgate Street), at 6.—General Sir W. B. Leishman: Bacteriology of Disease.

TUESDAY, NOVEMBER 21.

ROYAL SANITARY INSTITUTE, at 4.—Lt.-Col. W. W. Clemesha: Hookworm Disease and the Method of Controlling It. At 5.15.—Miss A. D. Muncaster: Some Hygienic Aspects of Food and Food Preparation. II. The Hygiene of Food Preparation (Chadwick Lecture).

WEDNESDAY, NOVEMBER 22.

ROYAL SANITARY INSTITUTE, at 4.—Prof. R. T. Leiper: Parasitic Worms and their Migrations.

THURSDAY, NOVEMBER 23.

ROYAL SANITARY INSTITUTE, at 4.—Lt.-Col. H. J. Walton: Flies and Mosquitoes.
UNIVERSITY COLLEGE, at 5.—Prof. H. R. Kenwood: The Pasteurisation of the Public Milk Supply.
WESTFIELD COLLEGE (Hampstead), at 5.15.—Sir Oliver Lodge: Matter and Ether.

FRIDAY, NOVEMBER 24.

ROYAL SANITARY INSTITUTE, at 4.—Dr. H. B. G. Newham: Malaria and other Diseases.
UNIVERSITY COLLEGE, at 5.15.—Prof. J. E. G. de Montmorency: Law and the Humanities.
BEDFORD COLLEGE FOR WOMEN, at 5.30.—M. L. W. Laistner: Ancient University Life.

SATURDAY, NOVEMBER 25.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—F. Balfour-Browne: British Water-beetles.

SATURDAY, NOVEMBER 25, 1922.

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Cambridge and the Royal Commission.

IN the current number of the *Quarterly Review*, Sir William Ridgeway publishes a critical account of the recent report of the Royal Commission. As is not unexpected, he differs fundamentally from the Commissioners on certain points. First of all he opposes the principle of accepting State grants with, as he suggests, "the uncomfortable corollary of State control." He fears that this will be of the nature of "continuous administrative control" and that Cambridge will lose that liberty of spirit and initiative which have built up her present strong position in the scientific and educational world. Many of those who do not share Sir William Ridgeway's fears will agree with him that much trouble to all concerned will be saved, and some freedom from Parliamentary pin-pricks from cranks or extremists will be secured, if the grant which the Commissioners recommend can be charged on the Consolidated Fund.

The second main criticism is that the Board of Studies and Research, the body charged with the control of the studies of the University, is placed too directly under the Council, the administrative body of the University. As the electorate which chooses both bodies is the same, any serious difficulties that may arise through differences of opinion between the administrative and teaching members of the University would always be capable of early adjustment. As the teachers are in the majority, the side that would presumably suffer in any such conflict as Sir William Ridgeway foreshadows would be the administrative side. On the ground which he has chosen it is doubtful whether the criticism can be maintained. On other grounds there is a great deal to be said against the majority of so important a body in the University as the Board of Studies being nominated by the Council.

The main attack of Sir William Ridgeway is, however, levelled against the proposals of the Commission to reduce the powers of the Senate, the non-resident graduates, and to give them no longer the final say in all serious matters of University policy. In his criticism of detail Sir William Ridgeway is not happy. When he says "The Cambridge Commissioners know perfectly well that it would not be easy to get fifty signatures to any appeal within a week," the obvious answer is that Sir William Ridgeway knows perfectly well that in any issue of importance where an appeal to the Senate is likely, fifty signatures could be collected in the Senate House from the defeated minority at the conclusion of the poll.

On the general question whether the ultimate control should lie with the Senate or with the House of Residents, there is naturally much divergence of

opinion. Sir William Ridgeway repeats an old challenge to the supporters of the House of Residents to cite a case where the Senate has outvoted the local body. There may be only one case, the recent compromise on the admission of women to the University. But the charge against the Senate's vote is that, as is perhaps only too natural with the older members of the University, the Senate's vote is consistently and steadily against change—or, if an alternative is presented, for the least possible change offered to its choice. Its control is capricious in so far as its intervention is made at the capricious decision of a body of resident conservatives who, through the Senate, wield a wholly disproportionate power on matters vitally affecting the well-being of the University.

The Study of Spectra.

The Physical Society of London. Report on Series in Line Spectra. By Prof. A. Fowler. Pp. vii + 183 + 5 plates. (London: The Fleetway Press, Ltd., 1922.) 12*s*. 6*d*.

A Treatise on the Analysis of Spectra: Based on an Essay to which the Adams Prize was awarded in 1921. By Prof. W. M. Hicks. Pp. viii + 326. (Cambridge: At the University Press, 1922.) 35*s*. net.

OF the two works now under notice, the first, by Prof. Fowler, is the third of the series of reports published by the Physical Society, its predecessors being those by Dr. Jeans on Radiation, and by Prof. Eddington on the Relativity theory. These set a very high standard, but the present work worthily maintains it, and we are glad, at the outset, to offer congratulations to the Physical Society on the continued service which it is rendering to science by their publication.

The choice of subjects for these reports has been singularly happy. The first two dealt with the matters which, at the time, were most prominently in course of development. This third report has at least an equal claim to attention on a somewhat different ground. The remaining problem which is most outstanding, both for the physicist and chemist, and indeed for every scientific man, is that of the structure of the atom. Clues towards its comprehension are provided on every hand by the practical and statistical workers; but they never become final in their importance. After Balmer formulated his well-known expression for the hydrogen spectrum as an orderly arrangement, at least eight model atoms, constructed on entirely different principles, have been used to deduce it theoretically. Its simplicity alone condemns it as a decisive factor in our knowledge, and the practical worker, who shows us that, even artificially, elements can be broken up, takes us no further towards the formulation of the fundamental dynamical principles, all-embracing in their scope, which determine the behaviour and structure of an individual atom, once and for all, when we know the charge on its nucleus and the number of electrons pursuing their orbits.

The study of spectra must provide the final test of any atomic theory. Spectra can be measured with an accuracy far transcending that obtained in any other phenomena which bring us into touch with an individual atom, and spectra have never been measured systematically by any worker with the general accuracy obtained by the author of the present report. A remarkable part of the work described in this report is due to Prof. Fowler himself, not only in respect of the accuracy of measurement, but even more as regards the elucidation of the nature of the spectra and the conditions which regulate their appearance in the laboratory or in celestial bodies.

For many years spectroscopists have been at a great disadvantage. All the literature of their subject has been scattered, and a general compendium, written by one in the forefront of progress, has been perhaps the most urgent need of the physicist whose aim is the direct determination of the laws governing the motions in an atom of any element more complex than hydrogen. In the last resort, the test of a theory of any chemical atom is that its possible radiations can be determined, by pure mathematical analysis, as specific numbers with a degree of accuracy of at least one part in 10,000, which shall preclude any possible fortuitous coincidence. In certain cases this appears to have been done. Nicholson's investigation of the coronal spectrum, and Bohr's theory of the hydrogen and charged-helium spectrum, together with Wilson's and Sommerfeld's remarkable determination of the appropriate generalisation for elliptic paths of the electrons, appear, for example, to meet this necessity. But all such investigations are preliminary only, and nothing is certain till a more complex spectrum is so elucidated.

The material for such a generalised treatment of the quantum theory is presented in full detail by Prof. Fowler. The treatment is very lucid and this work will completely replace the more usual but out-of-date accounts, which the spectroscopist now has in his library. The present work may be expected to mark a definite epoch in the history of atomic theory as well as of spectra in their more limited scope.

The author, like Prof. Hicks in the other work under notice, is not concerned with particular theories. In a certain sense, however, Prof. Hicks is so concerned,

for he has asserted that a series spectrum does not follow a strict mathematical formula, but deviates from a "mean" formula in a manner expressible in terms of integral multiples of the "oun." These integral multiples are curious, and, without any wish to cast doubt upon the validity of the conception, perhaps a reader may be allowed to be amused when he learns that a line in a spectrum series, which has the power of deviating from its proper position by a specific number of ouns, should choose such numbers as 19, 59, and so on, rather than anything more simple, and seem to show preference for a large prime number.

We hope that this remark will not be interpreted as a severe criticism of Prof. Hicks, but it is one which every reader must make. The amount of computation which lies behind the results given by Prof. Hicks is stupendous, and it is quite impossible for the most hostile critic to deny that a substantial proportion of his series arrangements must be founded upon physical reality. At the same time, very serious difficulties will arise, in many cases, in the mind of a practical spectroscopist. There are undoubted instances in which Prof. Hicks's arrangement drives a definite spark-line into an arrangement of an arc-series. Such difficulties are not numerous enough to invalidate the author's point of view, which is at least as well fortified as that of any author who has claimed to give a *definite* formula for a spectrum series.

It is still possible to hold the position that all suggested formulæ for spectrum series are not more than empirical, and that their effectiveness is due solely to greater mathematical convergency and not to a closer correspondence with the "true" formula to which a physical theory should lead. Prof. Hicks rejects the possibility of this "true" formula, in favour of a divergence of all the lines, by arbitrary multiples of the "oun," from a "mean true" formula —a position which it is difficult for the theoretical physicist to accept. But he has done much to justify his belief, and his work renders very great service towards the orderly arrangement of series.

The volume is very difficult to read, for the author continues his practice of giving only the *difference* between the observed and calculated position of any line. This sometimes involves a long calculation before the line discussed can be identified. A recurrence of this trouble several times in rapid succession creates a feeling of hopelessness. But perhaps the size of the book would have been doubled if the author had attempted to relieve the reader.

Prof. Hicks's work is a monumental treatise on the arrangement of spectra in series, and is at least an indispensable addition to the library of any spectroscopist. The two works together place this subject on an entirely new footing, and the physicist, who hitherto has obtained his knowledge of spectra from a scattered series of papers, now has a real opportunity to assimilate all the main points, and to co-ordinate the knowledge of atomic structure so derived with that obtained from more familiar but less precise data.

Animal Venoms.

Animaux venimeux et venins. Par Dr. Marie Phisalix. Tome Premier. Pp. xxvi+656+iv pls. Tome Second. Pp. xii + 864 + xiii pls. (Paris: Masson et Cie, 1922.) 120 francs net.

To most of us the term "venomous animal" suggests a snake, a wasp, a spider, a scorpion, a centipede —perhaps also a toad, a fish or two, or a jelly-fish. Readers of this book, however, will learn that venomous animals are to be met with freely in all the phyla of the animal kingdom, except such sequestered or unobtrusive groups as Tunicata, Polyzoa, Brachiopoda, and sponges—although even the harmless necessary sponge in its native haunts may consort with a vicious sea-anemone.

The immunity to notoriety possessed by a diversity of venomous creatures is due partly to the fact that the subject has never, before the publication of these volumes, been treated as a connected and comprehensive story; and perhaps in even larger measure to the circumstance that we are apt to think of stings and fangs and spines as necessary attributes of venomous creatures, and to forget that besides toads there are plenty of venomous animals unprovided with any special and obvious weapons for discharging their venom.

In these two large volumes pretty well all that is known about venomous animals of all kinds has, at last, been collected and systematically arranged—and by authors who, during the course of many years of exact study, have themselves made many fresh contributions to this particular store of knowledge. Thus, although the work may be called a compilation, and may be accorded all the merit of novelty as such, it must also be invested with much of the higher excellence of an original creation.

A preface by the lamented Laveran states that the treatise was projected many years ago when Mme. Phisalix was collaborating with her husband, Dr. Cæsar Phisalix (who in 1894 was awarded, conjointly with Dr. C. Betrand, the Montyon prize of the Academy of Sciences "for the general results of their work on venoms, forming the scientific basis of anti-venomous therapy"), and that after her husband's premature death in 1906 it was continued and completed by herself.

From the introductory chapter we understand that the term animal-venom is taken in its widest sense, to include not only tangible secretions, like snake-venoms, which are elaborated and discharged, with intent to do hurt, by special apparatus, but also toxins like those attributed to pathogenic Protozoa, of which the existence is inferred rather than conclusively demonstrated. In this broad outlook the obvious function of an animal-venom as a gross means of defence or attack, becomes a very special and striking development of a general cellular disposition to defence or retaliation; and from this point of view the manufacture of toxin is to be seen as a primitive function of wide prevalence in the animal kingdom, and the manifestly venomous animals in each zoological group are to be regarded as a sort of powerful or privileged caste. To the cynic it may perhaps be some consolation to reflect that in Nature's livery we are all more or less toxic—that one touch of toxin makes the whole world kin.

This theory of a general prevalence of animal toxins and of their function, like other secretions, in influencing the nutrition of the individual, the influence in this case being to stimulate cellular resistance and ultimately to provoke natural immunity to poisons in general, is elaborated in a final chapter on the functions and uses of venoms, where also there are some interesting remarks on the therapeutic employment of animal-venoms in ancient and modern times, and some justifiable anticipations that snake-venoms may find a further place in the scheme of rational therapeutics. The part played by their venom in the digestive processes of snakes appears to be disregarded.

Outside these most interesting initial and final chapters are to be found about 1500 pages of considered facts set down in zoological and historical perspective, the general tone being academic, though accidents due to venoms and their treatment are not disregarded. Each zoological group is treated separately, in the anatomical details of the specific venom apparatus, in the physiological properties and pathological effects of the specific venoms, in historical and bibliographical particulars, and also as much as possible from the point of view and bearings of natural and acquired immunity. There is perhaps rather too much admixture of pure zoology of a kind that can scarcely be countenanced as relevant, *e.g.* the 116 pages given to taxonomy and distribution of snakes, over and above 125 pages devoted to pertinent anatomical description, is perhaps an extreme example of this superfluity.

As might be expected, the chapters on venomous reptiles and amphibia are the strongest, and those on groups, such as parasitic worms, in which the sources of the toxins are to some extent a matter of speculation, are the weakest. Naturally also in the chapters on the invertebrate groups, those on scorpions and certain Hymenoptera contain the most original matter. Considerable space is allotted to spiders and the effects of their venom—enough to correct any lingering incredulity as to the serious possibilities of spider bite. Ticks, however, are dismissed in 18 lines, and Annelida and parasitic Crustacea are not noticed at all. Fishes are dealt with very fully in three categories, according as they are venomous in spine or tooth, or persistently or periodically toxic as food, or possess notably toxic blood. The amphibia, on the venoms of which Mme. Phisalix is a particular authority, are very thoroughly considered. In dealing with the venomous lizard, Heloderma, the author also draws freely on her own researches in the laboratory, as well as from vivid personal experience of the effects of its bite. Venomous snakes occupy more than two-fifths of the entire treatise; among them are included not only the vipers and sea-snakes and elapine and opisthoglyph colubrids, but also a number of aglyph colubrids, Boiidæ, Ilysiidæ, Uropeltidæ, and Amblycephalidæ, which possess a poison gland, though they are destitute of grooved fangs for injecting the secretion. The text is illustrated throughout by figures, and there are some coloured plates that reach perfection.

Of the book as a whole it is not enough to say that it represents a perfectly amazing amount of devoted labour in a fascinating field, or that it is the most complete and comprehensive treatise in existence on the subject of venomous animals. It is something more than this; and from the touching circumstances of its inception and the motives that helped to sustain its progress, as recorded in the preface by Laveran, one may be permitted to think that its accomplishment might, without, in this case, any taint of vanity, have finished with the proud conclusion *Exegi monumentum.*

A. A.

Crime and Remedial Punishment.

Penal Discipline. By Mary Gordon. Pp. xiii + 238. (London: G. Routledge and Sons, Ltd.; New York: E. P. Dutton and Co., 1922.) *7s. 6d.* net.

CRIME and criminals are subjects in which most of us are interested to a greater or less degree. The causes of crime, the development of an accidental into a confirmed criminal, and his treatment and mode of life in prison are things we like to read about, and some of us ponder over them. How far ameliorated conditions improve, or to what extent harder conditions deter, the prisoner are questions frequently discussed by sociologists and by the general public. Much has been written by theorists and idealists; others with practical experience as officials or prisoners have given

their views, frequently at considerable length, and all sorts of reasons and theories as to the classification, reformation, segregation, and even extinction of offenders have been promulgated.

It is now generally accepted that there is no so-called "criminal diathesis," no specially fore-ordained, criminally disposed individuality. The theory of crime as a form of conduct, so ably argued by the late Dr. Mercier, is generally accepted. We are all potential criminals, some more some less, and our tendencies to different forms of law-breaking are of different potentialities. According to our mental constitutions, physical circumstances, environmental temptations, and emotional control, are our powers of resistance to deviation from the normal, in our domestic and civil life. Society in self-defence has laid down a code of conduct for us founded on custom, morality, and religion, this code being designated as the "law." It is enforced by what are called punishments, and according to the gravity of the offence against these laws, these punishments vary, from a small monetary fine through varying terms of seclusion in state institutions, up to the extreme penalty, the death sentence. It is in these institutions—prisons—that deterrent and reformative influences are brought to bear on the offender—penal discipline—with the object of preventing further offences by him or her against the law.

It is to the question of penal discipline that Dr. Gordon applies herself in the work under notice. Her experience as Lady Inspector of Prisons for a period of thirteen years has enabled her to form her own opinion on the matter, and, although her knowledge is solely that of the female offender, yet in her generalisations she has no hesitation in including the other sex. The book is well written and interesting to read, and it gives pen-pictures of several types of female, well known to any one who has come in personal contact with offenders of this sex. She discusses with ready pen and fluent language, inebriety, prostitution, venereal disease, tattooing, and the physical and mental characteristics of various offenders. The different penal institutions, local and convict prisons, and preventive detention and Borstal institutions are all described, and are all, without exception, condemned. She has no good thing to say for any of them. They must all be "scrapped." They are not deterrent, and they do not reform. The reforms which have gradually been taking place during the past forty years and are still being effected in our prison treatment and discipline appear to her useless and unavailing. Those who have watched these reforms and seen their benefits in the course of their daily life during that period may hold different opinions as to their effect, but Dr. Gordon will have none of it.

Dr. Gordon's remedial and substitutional measures do not appear so definite as is her condemnation of the present prison system. Teaching of trades and agricultural and horticultural employment, which she recommends, are now in vogue in convict prisons, Borstal and preventive institutions, and in several of the larger local prisons. It will take some time to educate the British public sufficiently to allow prisoners to conduct their private business from their place of detention. If so, we may find some of our erring financiers who are now in seclusion using Wormwood Scrubbs or Parkhurst as business addresses from which to launch their schemes. The violent British convict will, we fear, not be awed into quietude by cells of matchboard lining, nor will the absence of lock and key and brick and mortar walls be so effective in detaining him as our author appears to think; nor will the permission to have his own medical attendant brought daily to his sick-bed be probably so beneficial to him as to change his whole mental, moral, and physical nature. Psycho-analysis may or may not become a beneficial instrument in this respect. Many of her schemes may be regarded as impracticable and Utopian, but on one point Dr. Gordon lays marked emphasis, and here we are wholly with her. Heretofore the practice has been to try the prisoner for the offence and to make the punishment fit the crime. The punishment, on the other hand, should fit the criminal. Laws are based on the assumption that the breakers of them are all equally responsible, if sane. If not sane there are other ways of dealing with them. But apart from insanity the degree of responsibility in different persons cannot be considered equal by any one who has had the care and observation of the inmates of prisons. Their mental outfit is of varying quality, and their fitness to carry out the duties of ordinary citizens, though theoretically in the eye of the law the same, is found practically in many cases to be quite different. That the retaliatory idea of punishment, *lex talionis*, (though generally supposed to be a relic of barbarism) has not yet been buried was clearly demonstrated in a recent case where Press and public joined in an outcry against the Home Secretary.

The personal equation and mental equipment of individual offenders is a point which should, in the future, be more clearly defined and inquired into before sentence, and this especially in the case of the young offender. The Mental Deficiency Act (1913) made it possible when congenital causes were demonstrable to send these cases to suitable institutions, but there are many now in prison who are clear cases for permanent detention, though the defect is not clearly traceable to congenitalism, and therefore they cannot be certified under this Act.

That the present system of prison administration has elasticity and progressiveness is shown by the policy towards these offenders at Birmingham and other centres, where special arrangements have been made for the observation and examination of any prisoner whose mental capacity seems impaired, by trained and efficient medical men. Here, after a period of detention on remand, where the offender is carefully observed, his previous history ascertained, and his psychology investigated, on the report or evidence of the medical observer, sympathetic justices dispose of the case in a manner which is most suitable to the circumstances of the individual, and not on the old stereotyped method of sentence following crime. In regard to Borstal institutions also, which at one time held out so much promise, the study of the individual offender is all-essential, and, though this is now done by the officials responsible, it is a matter of great doubt whether it can be carried out at all efficiently in a place where some 400 or 500 youthful offenders are congregated.

Dr. Gordon's book generally is well worthy of perusal, although we cannot accept all her conclusions or remedial methods on the subject of crime and criminals.

Our Bookshelf.

(1) *Microbiology*. Edited by Prof. C. E. Marshall. Third edition revised and enlarged. Pp. xxviii + 1043 + 1 plate. (London: J. and A. Churchill, 1921.) 21*s*. net.

(2) *Laboratory Manual in General Microbiology*. Prepared by the Laboratory of Bacteriology and Hygiene, Michigan Agricultural College. Second edition. Pp. xxii + 472 + 1 chart. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1921.) 21*s*. net.

(3) *Die Anaphylaxie*. By Prof. Ch. Richet. Autorisierte Übersetzung von Dr. med. J. Negrin y López. Pp. iv + 221. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1920.) n.p.

(4) *A Treatise on the Transformation of the Intestinal Flora, with Special Reference to the Implantation of Bacillus Acidophilus*. By Prof. L. F. Rettger and H. A. Cheplin. Pp. vii + 135 + viii plates. (New Haven: Yale University Press; London: Oxford University Press, 1921.) 12*s*. 6*d*. net.

(5) *Diagnosis of Protozoa and Worms Parasitic in Man*. By Prof. R. W. Hegner and Prof. W. W. Cort. Pp. 72. (Baltimore, Maryland: The Johns Hopkins University, School of Hygiene and Public Health, 1921.) n.p.

(1) PROF. MARSHALL's volume is a text-book of general and applied microbiology. The morphology, cultivation, and physiology of micro-organisms are first dealt with, and an excellent account of these subjects is given. If any chapter were to be selected for special commendation, we should choose Chapter II., partly perhaps, because of its novelty in a work of this kind, in which the physical forces involved in biological activities are described. An admirable summary is here given of such subjects as ionisation and dissociation, surface tension, adsorption, diffusion, and osmosis, colloids, and crystalloids—all of which are of fundamental importance for the understanding of biological activity. The second half of the book is devoted to applied microbiology, and accounts are given of micro-organisms in relation to air, water and soil, milk and foods, fermentations and disease, including the microbial diseases of plants and insects as well as those of man and animals. Twenty-five specialists in their various subjects contribute to the making of the book, and Prof. Marshall has edited and coordinated the whole. We know of no other book which in so limited a space gives such an excellent account, general and special, of micro-organisms in all their aspects. The text contains numerous illustrations.

(2) The second book on our list deals with micro-organisms from the practical laboratory standpoint. All the procedures employed for the study of micro-organisms are adequately described, and a series of class exercises for the study of organisms is detailed. The book forms a valuable practical laboratory manual, particularly useful for the teacher.

(3) Prof. Richet's book on the difficult subject of anaphylaxis is well known, and the volume before us is a translation from the French. The phenomena of the condition are fully described, the hypotheses of its causation are detailed, and a considerable bibliography is appended.

(4) The account of work accomplished in the Sheffield Laboratory of Bacteriology, Yale University, constitutes a valuable monograph, and will be indispensable to all those working on the microbial flora of the intestinal canal. An excellent historical review of the subject is given in the opening pages, a copious bibliography is appended, and the technique employed by the authors is described. The theme investigated is the transformation and simplification of the ordinary mixed intestinal bacterial flora through the diet, in conjunction with the oral administration of cultures of bacteria. This was claimed by Metchnikoff to be possible by the administration of milk soured with the *Bacillus bulgaricus*; but the authors state they invariably failed to accomplish this. By the use, however, of *Bacillus acidophilus* in place of *B. bulgaricus*, the required transformation seemed to be attained.

(5) Profs. Hegner and Cort have produced a useful little book which gives a brief, and on the whole accurate, account of the commoner protozoan and helminthic parasites of man so far as is required for diagnostic purposes; in this respect the several illustrations are a useful adjunct. It is just the book for the clinical laboratory and the medical practitioner.

R. T. HEWLETT.

Insect Pests of the Horticulturalist: Their Nature and Control. By K. M. Smith and J. C. M. Gardner. Vol. 1: *Onion, Carrot, and Celery Flies*. Pp. vi + 76 + plates. (London: Benn Brothers, Ltd., 1922.) 7*s*. 6*d*. net.

THE three pests described in this work are among the most serious enemies with which the commercial grower has to contend. Unfortunately, no really adequate measures for controlling any one of them have so far been discovered. The celery-fly, in its

larval stage, mines the leaves of both celery and parsnip. Owing to the concealed mode of life pursued during this period of its development, the insect is exceedingly difficult to kill by means of any feasible insecticide. Mr. J. C. M. Gardner, who is responsible for the section on the celery-fly, suggests the use of a spray containing chlororthocresol as a deterrent preventing the insect from egg-laying on the plant. He also suggests that a certain number of plants (presumably he means those of the parsnip) should be left in the ground to continue growth for a second year. Plants thus left were found, in a private garden, to be heavily infested, while neighbouring seedlings were only slightly attacked. It is, therefore, possible that the two-year-old plants might serve as a trap crop which, when heavily infested, could be pulled up and burnt. The idea, however, needs testing thoroughly on a practical scale.

Mr. K. M. Smith's account of the metamorphoses of the carrot-fly is a useful contribution, and the only complete description available. As regards control measures, he suggests the application of 1 part of green tar-oil to 99 parts of precipitated chalk, scattered between the rows as a deterrent to egg-laying. Since the eggs are deposited on the soil, and not on the plant, it will be seen that a thin application of this mixture may possibly also deter the young larvæ from reaching the plant, should it fail to act as a deterrent to egg-laying. Other repellent substances have also been tried by Mr. Smith, against both this insect and the onion-fly, with varying results. The book is suggestive, but it leaves the control of the pests with which it deals still in the experimental stage. It is clearly printed, and the illustrations are accurate.

The Feeding of Dairy Cattle. By Prof. A. C. McCandlish. Pp. xix+281. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1922.) 12*s.* 6*d.* net.

IN no branch of the art of feeding live-stock does practice tend to follow more closely the advance of nutritional knowledge than in the feeding of the milch-cow. The ease with which output can be measured, and the consequent facility of assessment of food requirements and economic returns, have rendered feasible a systematisation of this branch of feeding practice which is so far ahead of present possibilities in dealing with other classes of live-stock as to justify a specialised literature. The American student of agriculture has been well catered for in this respect in recent years, and the volume under review represents the latest addition to a list already long enough to warrant a critical attitude towards further additions. The justification of its issue does not rest on any appreciable novelty of material or method of presentation, but on the skilful manner in which the author has succeeded in giving in so few pages a thoroughly practical, lucid, and trustworthy survey of the subject, which cannot fail to be most useful to the practical man and practically minded agricultural student, for whom it is intended. The book is divided into five sections, the earlier sections being essentially scientific and leading up to the more detailed exposition of feeding practice, to which the last, and largest, section is devoted. The most recent developments in the science of nutrition receive adequate notice, and their possible bearing upon practice is treated with commendable judgment and restraint. The book worthily fulfils the purpose for which it was intended, and may be cordially commended to progressive dairy-farmers and students in "farm institutes."

Lehrbuch der anorganischen Chemie. Von Prof. Dr. Karl A. Hofmann. Vierte Auflage. Pp. xx+751 +7 Tafeln. (Braunschweig: F. Vieweg und Sohn, 1922.) 300 marks; 24*s.*

THE fact that successive editions of Dr. Hofmann's "Inorganic Chemistry" have been issued in 1917, 1919, 1920, and 1921, is sufficient evidence of the popularity which it has achieved in German-speaking countries. The scope is very similar to that of English text-books of similar price, although it differs from these in containing a large amount of matter in small type and very few illustrations. Characteristic features are the postponement to the end of the book of a series of special subjects, which include explosives, co-ordination-compounds, the structure of crystals, radio-active substances, the structure of the atom, and the distribution of the elements. The theoretical introduction is therefore extremely brief, and the periodic classification of the elements is discussed in the body of the book without any reference to atomic numbers or isotopes. In view of the scantiness of the illustrations it is remarkable to find six figures given up to pictures of burettes, pipettes, and measuring flasks and cylinders in a section dealing with caustic potash. The seven plates which illustrate the flame-spectra of the elements, the line-spectra of the principal gases, and the absorption spectra of the rare earths are, however, excellently reproduced, and form a very pleasing appendix. It is, however, doubtful whether English readers will care to face the handicap of a foreign language in order to obtain instruction which they can assimilate with much greater ease from text-books in their own language.

Radio for Everybody. By A. C. Lescarboura. Edited by R. L. Smith-Rose. Pp. xii+308. (London: Methuen and Co., Ltd., 1922.) 7*s.* 6*d.* net.

MOST people are interested at present in radio-broadcasting, and there are many who are contemplating the purchase of a receiving-set. It will be of interest to them, therefore, to know how broadcasting has fared in America and the kind of programmes which are daily issued to the public. Specimen copies of these programmes are given. It appears that vocal and instrumental music, speeches and "talks," sermons and stories for children are the most popular items. The book contains an interesting chapter on the development and present position of radio-telephony in Great Britain. It is anticipated that radio-broadcasting will soon be as popular in this country as it is in America. We think, however, that the user of a receiving-set will find that on about one of every five days in this country receiving will be seriously interfered with by atmospherics. The rest of the book gives a popular but accurate account of the various kinds of radio-apparatus. There is no doubt that the mystery and fascination of the art of radio-communication is attracting many boys to take up applied electricity as a career.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Speculation concerning the Positive Electron.

I WRITE hypothetically, and in an interrogative mood except that I scarcely expect a present answer, but it is simpler to state a hypothesis with preposterous dogmatism, in imitation of the unconscious manner of the crank.

According to Larmor's theory the positive and the negative electrons can only differ, or at least must chiefly differ, in one being the mirror-image of the other. One for example might be a concentrated locked right-handed screw-twist in the Ether, while the other would be a left-handed contortion of precisely the same kind, simultaneously and inevitably produced, and connected with its fellow by transferable lines of force. Both would incidentally have to involve also a residual strain or tension, proportional to the square of the twist and inversely as the distance from it.

Needless to say, no positive electron in this sense has yet been discovered. If they exist, why not? Because electrons of both kinds are so extremely mobile, and the forces between them so immense, that they instantly bind themselves together into a compact and exceedingly stable structure, consisting of some hundreds or thousands of each kind; the simplest and lightest of which composite structures we know as the proton or hydrogen nucleus. Short of that grouping, the compound units are either too fully neutralised to be perceived, or else too greedy of each other to exist separately. The proton, for the first time, allows a single electron to be free enough to revolve permanently round the close-packed group without being utterly absorbed and incorporated in its composition.

A number of protons can unite and form the nuclei of other atoms, and in this case several free electrons can remain incompletely assimilated, so as to form a satellite system characteristic of each different element. Such composite nuclei can be shattered by adequate means, but the single nuclei are very stable, and the proton itself has not yet been near disintegration; nor is it clear whether anything detectable could result from its fracture, especially if the fragments were electrically neutral.

But now comes a question, difficult to answer on the mirror-image hypothesis:—Why should only negative electrons occur in the satellite systems? Why should not some atoms have nuclei with a surplus of negative charge, and be attended by positive electrons?

Possibly an answer may be forthcoming from those who either now or hereafter understand the formation of an α-particle, and why it has two positive—and always positive—charges; for it seems to form an essential intermediate ingredient in the building-up process.

But assuming that no answer is forthcoming; are we quite sure that no atoms are of the exceptional variety? Can such a variety exist? It seems a possibility just worthy of contemplation, unless experimental observation already absolutely negatives it. Photo-electric evidence is strong; the Zeeman effect appears conclusive. But is it final? It demonstrates clearly enough that the radiating particle has an electro-chemical equivalent of the order 10^7, and is therefore an electron of some kind, but is it conclusive about the sign in all cases? Perhaps it is: but there is no harm in reconsidering a conclusion occasionally, even if the already accepted answer turns out quite indubitable.

If all radiation is from the negative electron only, that curious fact would seem to point to some striking qualitative difference between the negative and the hypothetical positive electron: a difference which on Larmor's theory of the Ether is difficult to grant, though it may have to be granted. It is owing to this difficulty that there has arisen the otherwise attractive idea of a positive electron so intensely concentrated as to be about 1/1800th of the linear dimension of the negative electron, and therefore to possess incomparably greater inertia. This may be the right way out of the difficulty, but it requires proof.

If, pending proof, we try to work with a mirror-image pair of electrons, can we anyhow account for the apparent fact that atoms have only negative satellites? Perhaps thus:—Consider a crowd of new-born electrons, both positive and negative. If, among the manifold chances of structural packing, something less than half of the atomic nuclei formed were of the kind with positive satellites, while the other approximate half were of the negative satellite variety, the two classes would speedily combine with a violence inappropriate to anything that can be called molecular combination. They would thereby form the tight-packed and stable nuclei of heavier atoms, until the complexity was great enough to result in instability. That may be how the heavier atoms were formed. If the packing took place by chance, there might be a small surplus of one variety in excess.

The combination of nuclei would only cease when they were protected by a screen of similar electrons; their sign might be + or might be − but could not be both. In other words the resulting atoms could not be of opposite varieties; the satellites of the surplus variety must be all of one sign, or the atoms would combine with each other and form a new substance. Thus we could get the outlying satellites of one sign, either in every case or in so vast a preponderance of cases that no exceptions are as yet manifest. In the nascent stages there might be a random distribution of the two varieties, in numbers nearly equal but not accurately equal, like the male and female of a population; then most of them would mate and constitute higher nuclei, while the variety which happened to be in the majority would remain as it was, and become conspicuous. The number mated might be a hundred times greater than the number of outstanding single ones and yet these last would be what we know as the atoms of the elements familiar to-day. It is plain that the number of protons embedded in the nuclei of all the atoms must be in excess of the number of atoms themselves. The atoms themselves represent the surplus, the excess kind that could find no partners. The number of protons embedded in atomic nuclei are $\frac{(1+2+3+\ldots+92)}{92}$ times the number of known atoms, say 46 times as numerous.

Some fallacy here: for the elements are not all equally plentiful. But the middle ones are on the whole the most plentiful, and the statement may pass as a rough approximation.

Directly a positive variety of atom gets loose, it will combine with the nearest negative variety accessible, and push it a step or two up the series. In that way heavier elements may still occasionally be born. The free life-time of the less plentiful variety would be too brief for ordinary detection;

but now that shattering of nuclei is possible, and now that rapid means of detection are feasible, there is something to look for. The formation of strange substances and unusual combinations may be expected, and the composite nature even of the proton may yet be demonstrated by the emission of something fractional of extreme instability. Does not the atomic bombardment of aluminium already yield particles of extra long range ?

I make no apology for this surmise. Speculation as a temporary working hypothesis is sometimes suggestive of further experiment, and that is its sole justification. If the tendency of the discussion is to uphold the greater simplicity of the extra-small and extra-massive indivisible positive particle, well and good ; but that would rather close the door on one line of experiment, and it is not well to abandon the mirror-image idea prematurely. The proton *may* be an indivisible ultimate unit ; but that seems unlikely, and we have learnt not to negative the possibility of ascertainable structure lightly. It seems barely credible, now, that it was as an indivisible ultimate unit that we used to regard the atom !

The hypothesis that a proton is built up of positive and negative but otherwise identical electrons may yield a hydrogen nucleus too bulky for the facts, and may otherwise have to be rejected, but the idea at least leaves the door open to the extraordinarily brilliant experimental physicists of to-day, and hence as long as possible may be tentatively and provisionally encouraged. OLIVER LODGE.

Normanton, Lake, Salisbury.

The Measurement of Intervals.

I CANNOT resist Mr. Cunningham's invitation in his review of my Romanes Lecture (NATURE, Oct. 28, p. 568) to justify more precisely the transition from the picture of world-history as a tangle of world-lines to the scheme of intervals filling a continuum of space-time and demanding non-Euclidean geometry. " Prof. Eddington seems to contemplate as 'measurable' the intervals between pairs of points in this continuum which do not correspond to events in the history of any particle or electron in the material universe. But we wish to ask him how these intervals are in practice to be measured." Mr. Cunningham's point is that the picture which we have to dissect is the *actual* history of the world, and we are not allowed to alter it—to introduce measurements which never were made, or to introduce physically recognisable events at points where nothing actually happened. I accept this limitation. He admits, however, that all measurements that have ever been made are contained in the picture, and, I might add, all measurements that ever will be made. Thus we have a large number of measured intervals available for discussion ; and I think that Mr. Cunningham, like myself, is convinced that the geometry which these measured intervals obey is not exactly Euclidean but is given correctly by Einstein. When once this geometry is determined we proceed to fill all space-time with *calculated* points and intervals ; just as we ordinarily fill all space with calculated points and distances after first determining the geometry by means of a few distances actually measured and a few points actually perceptible. Only a small number of the calculated points and intervals correspond to events and measurements in the historical picture ; but whenever there is a measured value it will agree with the calculated value.

As regards the status in physics of this scheme of calculated points and intervals, it does not seem necessary to make any hypothesis ; indeed, I scarcely know what hypothesis could be made about it. At the back of my mind I vaguely suppose that it is " closely descriptive " of an underlying relation-structure of the actual world ; but whatever that means (if it means anything) it is too indefinite to use as an hypothesis. It is sufficient that we find it profitable to talk about this scheme. But at least its status is in no way inferior to the picture of tangled world-lines which Mr. Cunningham finds it convenient to start from. Material particles and events outside us are not directly observed : they are inferred from the fields (inertial and electromagnetic) which affect our bodies. But the field itself is not directly observed ; it produces disturbances in the bundle of world-lines called a man. Inside the man the disturbance passes from field to matter and matter to field in endless cycle. Who shall say at what phase of the cycle it takes the final plunge into the realm of consciousness and actuality ? Rightly or wrongly the method of science has always been to generalise from observation—to talk about a world which includes all that has been observed and a great deal which has not been observed. The astronomer does not make the *hypothesis* that the moon exists when nobody is observing it ; but he finds it profitable to talk about a conceptual picture which contains a continuously existing moon. The scheme of calculated points and intervals (æther, or field) or of tangled world-lines (matter), or preferably both together, forms the world which the physicist finds it profitable to discuss ; he can scarcely attribute more virtue than that to any world without wandering into metaphysics.

I must dissent entirely from Mr. Cunningham's statement that " any geometrical system whatever may be used for the purpose of attaching intervals." Clearly if a wrong geometrical system is used, the *measured* intervals will expose it by their disagreement. But Mr. Cunningham in this passage seems to use the word interval as though it had no fixed meaning and he could make it mean what he liked. If I recollect rightly, I originally introduced the name " interval," preferring it to the name " line-element " then current, which seemed unsuitable for a physical quantity as savouring too much of pure mathematics. I intended " interval " to mean a definite physical quantity—quite as definite as " energy," for example ; and I desire to guard its meaning jealously. If the meaning of " energy " can be altered at pleasure, it is easy to upset the law of conservation of energy ; and similarly by treating " interval " and " length " as words meaning nothing in particular, Mr. Cunningham has no difficulty in disposing of my contention that the world is not a Euclidean or flat world.

It will be seen that Mr. Cunningham and I are essentially in agreement that the merit of the Einstein scheme of intervals is its simplicity—" profitable to talk about "—rather than some kind of metaphysical significance. He regards it as selected from many other possible schemes because it gives a simple representation of the motion of particles and light-rays. That is a quite good enough reason for selecting it, but it must be borne in mind that it is not the historical reason for choosing it. The fact that it describes the exact motion of Mercury in a particularly simple way was only discovered after the whole scheme had been completed. The interest of Einstein's scheme is that there is, not one reason, but several reasons for selecting it. Not the least important of these reasons is that the scheme expresses the geometry of the world—in the sense in which the

word "geometry" is commonly understood, *e.g.* by the Board of Education.

One remark as to Newton and the apple, which I intended to typify a supported observer and a continuously falling observer, respectively. If, with Mr. Cunningham, we take the apple to typify an observer at first supported and afterwards free, the apple's view of things is appallingly complicated—compared even with Newton's. But that only the more emphasises the point that the natural simplicity of things may be distorted *ad libitum* by the process of fitting into an unsuitable space-time frame.

A. S. EDDINGTON.

Observatory, Cambridge, November 3.

I AM obliged to the Editor for giving me an opportunity to add a few words in comment upon Prof. Eddington's letter, and I do so in no captious spirit, but because it seems to me that in these very fundamental discussions it is of the utmost importance to clear away as many misunderstandings and difficulties as possible; to recognise that some divergences are merely consequences of viewing the same matter from different points of view, but that others may be due to looseness of thought on one side or the other; and I am glad to be able to recognise that most of the divergence of Prof. Eddington's exposition of the meaning of Einstein's theory from my own understanding of it is merely part of the difference between our natural ways of thinking. But two sentences in Prof. Eddington's letter do sum up my difficulty in regard to his exposition so clearly that I would like to direct attention to them.

"He admits, however, that all measurements that have ever been made are contained in the picture, and, I might add, all measurements that ever will be made. Thus we have a large number of measured intervals available for discussion."

In this sentence Prof. Eddington begs the whole question with which I ventured to end my review of his lecture. All measurements of length and all measurements of time that were ever made are, I agree, in the picture. But who ever measured this physical "interval"? What is the absolute scale of interval, and how is it applied? Again in Prof. Eddington's letter we read: "Clearly if a wrong geometrical system is used, the *measured* intervals will expose it by their disagreement." Unfortunately this is not at all clear to me, and I will try to explain why. So far as I can see, all actual physical measurements are records of observations of coincidences, *e.g.* of marks on a scale with marks on another body. That is to say, they correspond to intersections and concurrences of world lines of distinct physical elements. The significant feature of the four-dimensional picture of the universe is therefore merely the order of arrangement of such concurrences along the world lines of these physical entities. All else is of the nature of an arbitrarily adopted method of description of these orders of arrangement and is not contained in the picture itself. A geometrical system is an analytical means of describing the picture. The concurrences remain and their order is unaltered, no matter how we change our geometrical system. If I adopt a geometrical system other than that of Einstein, I may find the mathematics more complicated, but the actual observable facts recorded are the same—just as the fact of the meeting of the Great Northern, Great Eastern, Midland, and London and North-Western Railways in Cambridge station is quite independent of any particular brand of map or time-table. Of course a map which denied this fact would be wrong—but the adoption of a different geometrical system of attaching what I must not call "interval" to the separateness of two events does not break up a concurrence. It is just because *actual measurements* will not be altered by any change of the geometrical system that I cannot agree with the sentence I have quoted.

E. CUNNINGHAM.

St. John's College, Cambridge, November 11.

The Time-Triangle and Time-Triad in Special Relativity.

DR. ROBB directs attention in NATURE of October 28, p. 572, to the fact that there is much confusion of thought with regard to the stationary value of the integral $\int d\sigma$ in the special theory of relativity. When the path is purely temporal, as Dr. Robb was the first to point out, the integral is an absolute maximum, not a minimum. Prof. Eddington has also directed attention to this truth. The following view may be of interest. I give mainly the results, as the precise mathematical proof would occupy too much both of space and time.

Let A, B, C be the vertices (point-instants) of a *pure time-triangle* in the field of special relativity. Suppose C precedes A, and A precedes B *in proper time*; then it may be proved that C precedes B, *i.e.* proper time order is *transitive*. Then if *cosh* C denotes the unit-scalar product of the vectors CA, CB, and if α, β, γ denote the real and positive intervals BC, CA, AB, we have

$$\cosh C = \frac{\alpha^2+\beta^2-\gamma^2}{2\alpha\beta}.$$

It may be proved that the expression on the right-hand side is always positive and is greater than unity. Thus C may be regarded as the real invariant "*hyperbolic angle*" between the temporal vectors CA and CB. This angle has the same metrical value for all observers moving with uniform mutual relative velocities.

It can also be proved that $\alpha>\beta$. Hence, since $\cosh C>1$,

$$\alpha>\beta+\gamma.$$

That is, *the greatest side of a pure time-triangle is greater than the sum of the other two sides.*

It follows at once that the stationary value of the integral $\int d\sigma$, where the path is purely temporal, is an absolute maximum.

There is thus a real hyperbolic angle between any two co-directional temporal vectors. The triangle ABC has two real "internal" hyperbolic angles (B and C), and one real "external" hyperbolic angle A′. Besides the above formula we have

$$\cosh A' = \frac{\alpha^2-\beta^2-\gamma^2}{2\beta\gamma},\ \cosh B = \frac{\gamma^2+\alpha^2-\beta^2}{2\gamma\alpha}.$$

Taking positive signs for intervals and angles, we have

$$\frac{\sinh A'}{\alpha}=\frac{\sinh B}{\beta}=\frac{\sinh C}{\gamma}$$

and $\cosh (B+C)=\cosh A'$.

Thus *the one real external angle of a time-triangle is equal to the sum of the two real internal angles.*

The hyperbolic angle between two co-directional temporal vectors has a perfectly definite physical meaning, if the physics of special relativity is sound. Let CA and CB be the time-axes used by two

observers X and Y. The spaces which they use are normal to these axes. Then if v be their mutual relative velocity,

$$v = \tanh C,$$

the velocity of light being unity.

It may be added that the relation $B + C = A'$ is a particular case of the more general "triangle of relative velocities." Let OP, OQ, OR be a triad of co-directional non-coplanar temporal vectors (Dr. Robb's "inertia lines") cutting the "open hyper-sphere" (centre O)

$$u^2 - x^2 - y^2 - z^2 = 1$$

in point-instants P, Q, R, where u is the time co-ordinate. Let a, b, c be the geodesic arcs QR, RP, PQ *within* the hyper-sphere. These arcs are minima, not maxima; their elements in the limit are spatial in character, being normal to time-vectors; their hyperbolic tangents represent the mutual relative velocities of observers (X, Y, Z) who use OP, OQ, OR, or parallels thereto, as their time-axes. The Euclidean space used by X at any instant is parallel to the tangent space at P to the hyper-sphere, and from the point of view of X the directions of the relative velocities of Y and Z are the tangent-lines at P to the geodesic arcs PQ, PR. The angle between these directions is a circular angle (P), and the metrics of the geodesic triangle PQR are contained in the formulæ

$$\cosh a = \cosh b \cosh c - \sinh b \sinh c \cos P,$$

$$\frac{\sin P}{\sinh a} = \frac{\sin Q}{\sinh b} = \frac{\sin R}{\sinh c}.$$

When a, b, c are very small compared with the radius of the hyper-sphere the spaces of the observers are regarded as parallel, and we get the ordinary formulæ

$$a^2 = b^2 + c^2 - 2bc \cos P, \text{ etc.}$$

When OP, OQ, OR are coplanar we get the relation as before (with change of letters)

$$a = b + c.$$

The above remarkable formula for relative velocities was, I believe, first discovered by Dr. Robb, and is set forth by Dr. Weyl ("Space, Time, and Matter," § 22). I am not aware, however, that its direct connexion with the geodesic geometry of the open hyper-sphere has been explicitly noticed. R. A. P. ROGERS.

Trinity College, Dublin, October 31.

Space-Time Geodesics.

IN NATURE of October 28, p. 572, Dr. Robb pointed out the incorrectness of asserting that the length of a "world-line" is a minimum between any two points of it. He gave an example in which the length was neither a minimum nor a maximum. The object of his letter, no doubt, was to remind some reckless relativists that they should be more careful in their language. But there is the danger that some may suppose that he was dealing with a real weakness in Einstein's theory. To dispel this idea we may recall a few well-known facts.

Treatises on the geometry of surfaces (in ordinary three-dimensional Euclidean space) define *geodesics* in various ways. Some say that a geodesic is the shortest line that can be drawn on the surface between its two extremities, and they use the calculus of variations to find its equations. This method is open to criticism. The researches of Weierstrass have shaken our faith in the infallibility of the results obtained by an uncritical use of the routine processes of that calculus. But whatever may be said against the process employed, the equations of a geodesic finally obtained agree with those obtained by more trustworthy methods. For example, we may define a geodesic as a curve such that at every point the osculating plane is perpendicular to the tangent plane to the surface. From this definition we can easily obtain (cf. Eisenhart's "Differential Geometry," p. 204) equations which in the usual abbreviated notation of tensor calculus may be written

$$\frac{\partial^2 x_\sigma}{\partial s^2} + \left\{ \alpha\beta, \sigma \right\} \frac{\partial x_\alpha}{\partial s} \frac{\partial x_\beta}{\partial s} = 0, \quad (\sigma = 1, 2).$$

Einstein's equations ("The Meaning of Relativity," p. 86) are the obvious generalisation of these and differ merely in that the suffixes range over the values 1, 2, 3, 4, instead of only 1, 2. His notation is slightly different from the form given above, which is due to Eddington.

These equations can be obtained by at least two other methods. Einstein uses a "parallel displacement" method due to Levi-Civita and Weyl. Eddington ("Report on the Relativity Theory of Gravitation," p. 48) shows that the equations are satisfied (or not) independently of the choice of co-ordinates, and that they reduce to the equations of a straight line for Galilean co-ordinates. This straight line is described with uniform velocity, so Einstein's equations may be regarded as a generalisation of Newton's first law of motion.

Applying these equations to the example given by Dr. Robb, we find that his space-time curve does not satisfy them unless $F''(x) = 0$. This means that $F(x)$ must be a linear function of x and so it cannot fulfil the required conditions of vanishing for two different values of x, except in the trivial case $F(x) = 0$. Thus the ambiguity seems to lie, not in Einstein's equations of motion, but merely in a particular method of arriving at them.

As regards the desirability of modifying Einstein's ideas on the nature of time, it is hazardous to give a definite opinion at present. It may be noted that Prof. Whitehead's new book ("The Principle of Relativity") endeavours to combine all the verifiable results of Einstein's theory with somewhat conservative ideas concerning space and time. The modified theory leads to some remarkable predictions (p. 129) which should be tested by experiment.

H. T. H. PIAGGIO.

University College, Nottingham, November 4.

The Dictionary of Applied Physics.

THE issue of NATURE of September 30, p. 439, contained a highly appreciative review of the first volume of the "Dictionary of Applied Physics," and, as editor, I am much indebted to the author for his kind words. One remark, however, has, I gather, led to some misunderstanding; may I have space for a brief explanation?

Dr. Kaye directs attention to some of the "omissions," with the view of their future rectification. Most of these "omissions" will be found dealt with in future volumes of the Dictionary. Thus, in an article in vol. iii., on Navigation and Navigational Instruments, by Commander T. Y. Baker, the gyro-compass is treated of very fully, while, in vol. v., Mr. Dobson has a highly interesting article on instruments used in aircraft.

It has been part of my plan to separate the mathematical treatment of a subject and its practical applications. In this manner I hoped to increase the utility of the work to various classes of readers, some of whom are interested chiefly in the theory, while others are more closely concerned with the more practical details. R. T. GLAZEBROOK.

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Action of Cutting Tools.

IN the interesting letter which appeared in NATURE of August 26, p. 277, Mr. Mallock objects to the use of the word cutting as incorrect when applied to tools used for metal work, and it is surprising, therefore, to find that his own paper to which he refers in support of his contention is entitled "The Action of Cutting Tools," although it is almost entirely devoted to showing that the action of such tools is that of shearing.

In a further letter in NATURE, p. 603, of November 4, Mr. Mallock dismisses my paper as having no reference whatever to the action of cutting tools, apparently on the ground that it is entirely devoted to a consideration of elastic strains. So far as the tool itself is concerned, it is only useful so long as it does not become permanently deformed, and to the maker of tool steel, the stresses and strains produced within the elastic range are therefore matters of interest, so that an attempt was made in this paper to show the distribution of stress in the tool itself under these conditions.

In another section an account is given of the stress effects in the work when the tool is removing material therefrom, which are quantitative within the range for which the laws of photo-elasticity are known, and qualitative in the plastic region, as present knowledge is not sufficient to interpret fully the interference effects observed. Mr. Mallock ignores these latter effects, although they are undoubtedly of importance. They show, for example, that the action is sometimes discontinuous, and under other conditions is not so, although Mr. Mallock states quite definitely that it is always discontinuous and quasi-periodic. Mr. Mallock's letter also lays stress on the curling up of the shaving, but this does not always happen, as the discussion on my paper brought out the interesting fact that, as the speed increases, the curls of steel shavings increase in radius until at speeds of about two feet per second the shavings become practically straight and are often a danger to workmen. This effect has also been produced in nitro-cellulose at low speeds with a suitable tool, and it is then found that these straight shavings show permanent stress effects similar to those produced when a thin curved beam is flattened out.

E. G. COKER.

Engineering Laboratory, University College, London, W.C.1.

A New Worship?

"Therefore no man that uttereth unrighteous things shall be unseen;
Neither shall Justice, when it convicteth, pass him by.
For in the midst of his counsels the ungodly shall be searched out;
And the sound of his words shall come unto the Lord
To bring to conviction his lawless deeds:
Because there is an ear of jealousy that listeneth to all things,
And the noise of murmurings is not hid.
Beware then of unprofitable murmuring."

AFTER a period of ennobling worship in that greatest of our English Cathedrals, the Scafell massif, on my return to town I chanced to enter that strange building, Burlington House, wherein be installed many altars to the great god, Science. Visiting that which ranketh first, I found an impassive figure, seated in a chair, at the High Altar, with a brass bauble before him: he needed but the peculiar head-dress to be an Egyptian Priest-King. Moreover, the service was apparently Græco-Egyptian, if not Babylonian. The officiating young priest used many beautiful words clearly of Grecian origin, though at times an American phrase was noticeable, as when he spoke of Arrhenius doing chores, as I understood, for the god Isos. Most remarkable, however, was the way in which, at intervals, turning towards the altar, he solemnly gave utterance to the incantation—"See, Oh, Too!" My impression was that *Too* was the great king in the chair. The priest apparently was in fear of impending disaster, for at the close of his address he spoke much of concentration of the Hydrogen Ikons and their attack and repulse, often repeating the phrase "See, Oh, Too"—but Too seemed not to notice.

Two young acolytes then cast pictures of writing upon the wall as difficult to interpret as was that message expounded by Daniel in days long ago.

Most marvellous was the closing sermon, in which an account was given of the confusion wrought among a strange people, called "Lysodeiktics," by adding tears, nasal secretion, animal stews, turnip juice—seemingly muck of any kind—to their food: and how some of them were not killed. To one of an old faith, it seemed a strangely degenerate worship; indeed, that such service could be held worthy of attention amazed me.

In the evening, it chanced that I was led to peruse an article, in *The Times Literary Supplement*, on "Tradition and the French Academy," wherein is given Matthew Arnold's quotation, in his well-known essay, from the Academy's statutes:—

"The Academy's principal function shall be to work with all the care and all the diligence possible at giving sure rules to our language and rendering it *pure, eloquent and capable of treating the arts and sciences.*"

The whole article is worth reading; at the end is a quotation from a work by the late Pierre Duhem, the closing words being—

"le respect de la tradition est une condition essentielle du progrès scientifique."

It is scarcely necessary to point out the application of these quotations; yet shall I ever pray: See to it, Oh, see to it, great Oh, Too!

HENRY E. ARMSTRONG.

The Spectrum of Neutral Helium.

A MOST significant feature of the success of the quantum theory in explaining the sequence of radiation-frequencies forming the Balmer type of series in the spectra of hydrogen and ionised helium is that it also offers an intelligible explanation of the differences in the intensities of the successive lines in the sequence, and that its postulates are not inconsistent with the known facts regarding the sizes of the atoms in their normal states. The fundamental assumption in the theory is that the states of the atom represented by increasing quantum numbers depart more and more from the normal state, and the greater intensities of the earlier lines in a sequence are readily understood as due to the greater probability of transitions actually occurring between states represented by smaller quantum numbers.

Any attempt to build up a theory of spectra which ignores these fundamental considerations must be received with caution. The remark just made appears to be particularly applicable to Dr. Silberstein's attempt (NATURE, August 19) to explain the spectrum of neutral helium on the assumption of the independence of the electrons. Looking over the list of frequencies given in his letter, and comparing them with the maps and tables of the helium spectrum contained in Prof. Fowler's report, it is noticed at once that the well-known intense yellow line of helium at $\lambda 5876$, which is the first member of the diffuse series of doublets, is given by Dr. Silberstein the

formula 9/6 . 15/6, while other lines which are of vanishingly small intensity in comparison with it are assigned formulæ with much smaller quantum numbers. For example, the doublet at λ3652, which is the seventh in the sharp series and so faint that it fails to appear in the photographic reproduction of the spectrum, is assigned the formula 6/4 . 9/5. Similarly, the first diffuse singlet at λ6678 gets the formula 9/6 . 24/7, while the fifth in the same series is indicated by 7/5 . 19/5, that is, by much smaller quantum numbers, while it is actually a far fainter line than the other.

These facts naturally lead one to question whether Dr. Silberstein's proposed new combination principle has any real physical basis or significance. To settle this point, I undertook a careful survey of the figures and carried out a series of computations with the aid of my research student Mr. A. S. Ganesan, and have come to the conclusion that the approximate agreements between the calculated and actual frequencies are merely fortuitous arithmetical coincidences. This is clear from the following facts brought out by a survey of the figures :

(1) The proposed combination formula with its freedom of choice of four numbers gives a very large number of lines out of which it is possible to pick out a few coinciding approximately with practically any arbitrary series of frequencies which may be proposed, the accuracy of fit increasing as the quantum numbers chosen are increased.

(2) The coincidences between the calculated and observed frequencies are most numerous and accurate precisely in the region where the density of either series of frequencies is greatest, which is what we should expect according to the laws of chance.

(3) It is not, in general, possible to get a good fit for the earlier members of a line-series except by using large quantum numbers. This is what we should expect if the coincidences were fortuitous, as the frequency-differences between successive lines are greatest in the beginning of a series.

(4) More than one combination of quantum numbers will fit a given line tolerably well. For example, the D_3 line of helium is also represented fairly well by 13·21/5·12.

(5) The quantum numbers giving the best fit do not fall into any regular sequence when arranged either according to the frequencies of the lines or their intensities, nor do they show any characteristic differences for the singlet and doublet series.

Needless to say, the foregoing remarks apply with even greater force to the case of the lithium atom when a choice of six numbers is permitted.

Finally, it may be remarked that the Rydberg constant 109723 chosen by Dr. Silberstein is appropriate only to the case of the ionised helium atom in which only one electron is coupled to the nucleus. If both electrons exert reactions on the nucleus and move simultaneously, the value of the Rydberg constant cannot remain the same in general.

C. V. RAMAN.

210 Bowbazaar Street, Calcutta,
October 18, 1922.

Water Snails and Liver Flukes.

HAVING been attracted on several occasions by the presence of actively swimming cercariæ of *Fasciola hepatica* in material collected for protozoan studies and searching for the intermediate host, I have come across several examples of *Limnaea peregra* harbouring perfectly developed cercariæ of the same species. Prof. Graham Kerr has also had similar experiences.

May I claim the hospitality of your pages to ask of your readers for references to literature dealing with the subject of any intermediate host, other than *L. truncatula*, of the liver-rot parasite? Mr. Staig has kindly informed me that Prof. J. W. W. Stephens writes in "Animal Parasites of Man," by Fantham, Stephens and Theobald: "In the allied species of *L. peregra* the fluke will develop up to a certain stage but never completes all its various phases." Many text-books in zoology give one the impression that *L. truncatula* is the only intermediate host.

My experience in searching for *L. truncatula* is that the occurrence of the snail is very local in S.W. Scotland. It seems to be rare, or altogether absent in some districts. Yet in these districts the sheep are known to be infected with the liver-rot disease. It would seem, then, that *L. peregra* acts as the normal intermediate host in those districts, the Fasciola completing within its body in normal fashion the life cycle up to the stage when the cercaria becomes free.

MONICA TAYLOR.

Notre Dame, Dowanhill, Glasgow.

A Mutation of the Columbine.

LAST summer a remarkable mutation of the blue columbine (*Aquilegia cærulea* James) was discovered by Miss Madeline Gunn near the Smuggler Mine, in the vicinity of Ward, Colorado. Only a single plant was found, growing under a spruce tree. The flowers are of good size (about 63 mm. diameter), with the pale blue sepals deeply trifid apically, the divisions about 12 mm. long, broad basally, the outer ones overlapping the median one (Fig. 1). In one case the median division is bifid apically. The petals are white, the laminæ and spurs shorter than usual.

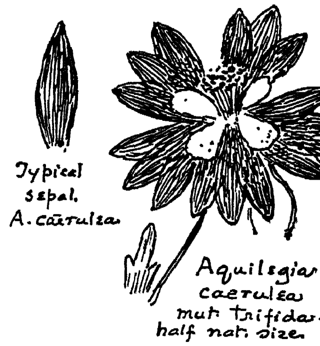

FIG. 1.

The form may be called *mut. trifida*; it represents a striking new type which, if it can be propagated, will be a notable addition to horticulture. Were it received from some remote region, it would appear to be a very distinct new species, or some might even wish to separate it generically. The trifid structure is characteristic of the divisions of the leaves of Aquilegia, and no doubt we may say that a quality of the leaf has been transferred to the sepals. Numerous cases of phyllody of the calyx in various flowers have been described by Maxwell Masters and others, but in this case the sepals are not at all leaf-like, and if such flowers were common they would not strike any one as abnormal.

T. D. A. COCKERELL.
DOROTHY YOUNG.

University of Colorado.

The Atoms of Matter; their Size, Number, and Construction.[1]

By Dr. F. W. ASTON, F.R.S.

THAT matter is discontinuous and consists of discrete particles is now an accepted fact, but it is by no means obvious to the senses. The surfaces of clean liquids, even under the most powerful microscope, appear perfectly smooth, coherent, and continuous. The merest trace of a soluble dye will colour millions of times its volume of water. It is not surprising, therefore, that in the past there have arisen schools which believed that matter was quite continuous and infinitely divisible.

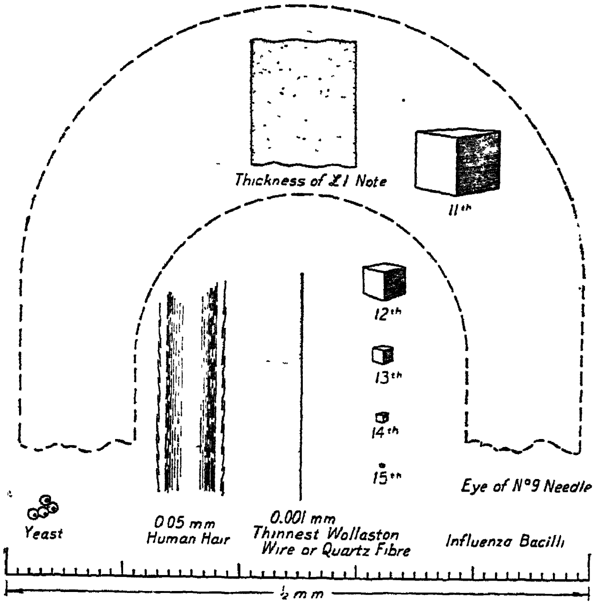

FIG. 1.—Cubes 11 to 15 compared with familiar objects to scale.

The upholders of this view said that if you took a piece of material, lead, for example, and went on cutting it into smaller and smaller fragments with a sufficiently sharp knife, you could go on indefinitely. The opposing school argued that at some stage in the operations either the act of section would become impossible, or the result would be lead no longer. Bacon, Descartes, Gassendi, Boyle, and Hooke were all partial to the latter theory, and Newton in 1675 tried to explain Boyle's Law on the assumption that gases were made up of mutually repulsive particles.

The accuracy of modern knowledge is such that we can carry out, indirectly at least, the experiment suggested by the old philosophers right up to the stage when the second school is proved correct, and the ultimate atom of lead reached. For convenience, we will start with a standard decimetre cube of lead weighing 11·37 kilograms, and the operation of section will consist of three cuts at right angles to each other, dividing the original cube into eight similar bodies each of half the linear dimensions and one-eighth the weight. Thus the first cube will have 5 cm. sides and weigh 1·42 kilograms, the second will weigh 178 gm., the fourth 2·78 gm., and so on. Diminution in the series is very rapid and the result of the ninth operation is a quantity of lead just weighable on the ordinary chemical balance. The results of further operations are compared with suitable objects and a scale of length in Figs. 1, 2, and 3. The last operation possible, without breaking up the lead atom, is the twenty-eighth. The twenty-sixth cube is illustrated in Fig. 3. It contains 64 atoms, the size, distance apart, and general arrangement of which can be represented with considerable accuracy, thanks to the exact knowledge derived from research on X-rays and specific heats. On the same scale are represented the largest atom, cæsium, and the smallest atom, carbon, together with molecules of oxygen and nitrogen, at their average distance apart in the air, and the helical arrangement of silicon and oxygen atoms in quartz crystals discovered by X-ray analysis. The following table shows at what stages certain analytical methods break down. The great superiority of the microscope is a noteworthy point.

Cube.	Side in Cm.	Mass in Gm.	Limiting Analytical Method.
9	0·0195	$8{\cdot}5\times10^{-5}$	Ordinary Chemical Balance
14	$6{\cdot}1\times10^{-4}$	$2{\cdot}58\times10^{-9}$	Quartz Micro-balance
15	$3{\cdot}05\times10^{-4}$	$3{\cdot}22\times10^{-10}$	Spectrum Analysis (Na lines)
18	$3{\cdot}8\times10^{-5}$	$6{\cdot}25\times10^{-13}$	Ordinary Microscope
24	$6{\cdot}0\times10^{-7}$	$2{\cdot}38\times10^{-18}$	Ultra Microscope
28	$3{\cdot}7\times10^{-8}$	$5{\cdot}15\times10^{-22}$	
Atom.	$3{\cdot}0\times10^{-8}$	$3{\cdot}44\times10^{-22}$	Radioactivity

Just as any vivid notion of the size of the cubes passes out of our power at about the twelfth—the limiting size of a dark object visible to the unaided eye—so when one considers the figures expressing the number of atoms in any ordinary mass of material, the mind is staggered by their immensity. Thus if

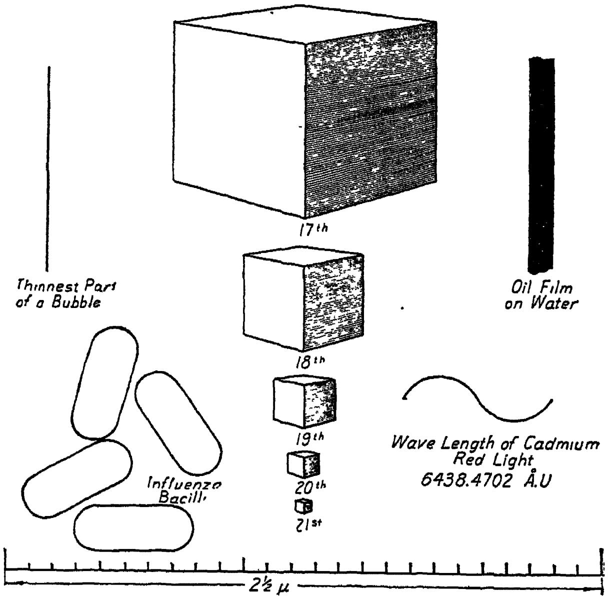

FIG. 2.—Cubes 17 to 21 compared with minute objects to scale.

we slice the original decimetre cube into square plates one atom thick the area of these plates will total one and one-quarter square miles. If we cut these plates into strings of atoms spaced apart as they are in the

[1] From an evening discourse delivered before the British Association at Hull, September 12, 1922.

solid, these decimetre strings put end-to-end will reach 6·3 million million miles, the distance light will travel in a year, a quarter of the distance to the nearest fixed star. If the atoms are spaced but one millimetre apart the string will be three and a half million times longer yet, spanning the whole universe.

Again, if an ordinary evacuated electric light bulb were pierced with an aperture such that one million molecules of the air entered per second, the pressure in the bulb would not rise to that of the air outside for a hundred million years. Perhaps the most striking illustration is as follows: Take a tumbler of water and—supposing it possible—label all the molecules in it. Throw the water into the sea, or, indeed, anywhere you please, and after a period of time so great that all the water on the earth—in seas, lakes, rivers, and clouds—has had time to become *perfectly mixed*, fill your tumbler again at the nearest tap. How many of the labelled molecules are to be expected in it? The answer is, roughly, 2000; for although the number of tumblerfuls of water on the earth is 5×10^{21}, the number of molecules of water in a single tumbler is 10^{25}.

From the above statements it would, at first sight, appear absurd to hope to obtain effects from single atoms, yet this can now be done in several ways, and indeed it is largely due to the results of such experiments that the figures can be stated with so much confidence. Detection of an individual is only feasible in the case of an atom moving with an enormous velocity when, although its mass is so minute, its energy is quite appreciable. The charged helium atom shot out by radioactive substances in the form of an alpha ray possesses so much energy that the splash of light caused by its impact against a fluorescent screen can be visibly detected, the ionisation caused by its passage through a suitable gas can be measured on a sensitive electrometer and, in the beautiful experiments of C. T. R. Wilson, its path in air can be seen and photographed by means of the condensation of water drops upon the atomic wreckage it leaves behind it.

In the first complete Atomic Theory put forward by Dalton in 1803 one of the postulates states that: "Atoms of the same element are similar to one another and equal in weight." Of course, if we take this as a definition of the word "element" it becomes a truism, but, on the other hand, what Dalton probably meant by an element, and what we understand by the word to-day, is a substance such as hydrogen, oxygen, chlorine, or lead, which has unique chemical properties and cannot be resolved into more elementary constituents by any known chemical process. For many of the well-known elements Dalton's postulate still appears to be strictly true, but for the others, probably the majority, it needs some modification.

Throughout the history of science philosophers have been in favour of the idea that all matter is composed of the same primordial substance, and that the atoms of the elements are simply stable aggregations of atoms of this substance. Shortly after Dalton's theory had been put forward Prout suggested that the atoms of the elements were composed of atoms of a substance he called "protyle," which he endeavoured to identify with hydrogen.

If Dalton and Prout were both right the combining weights of the elements should all be expressible as whole numbers, hydrogen being unity. Experimental evidence showed this to be impossible in many cases. Chemists therefore wisely preferred Dalton's theory, which was in accord with definite though fractional atomic weights, to Prout's, which would necessitate the elements of fractional atomic weight being heterogeneous mixtures of atoms of different weight.

The idea that atoms of the same element are all identical in weight could not be challenged by ordinary chemical methods, for the atoms are by definition chemically identical, and numerical ratios were only to be obtained in such methods by the use of quantities of the element containing countless myriads of atoms. At the same time it is rather surprising, when we consider the complete absence of positive evidence in its support, that no theoretical doubts were publicly expressed until late in the nineteenth century, first by

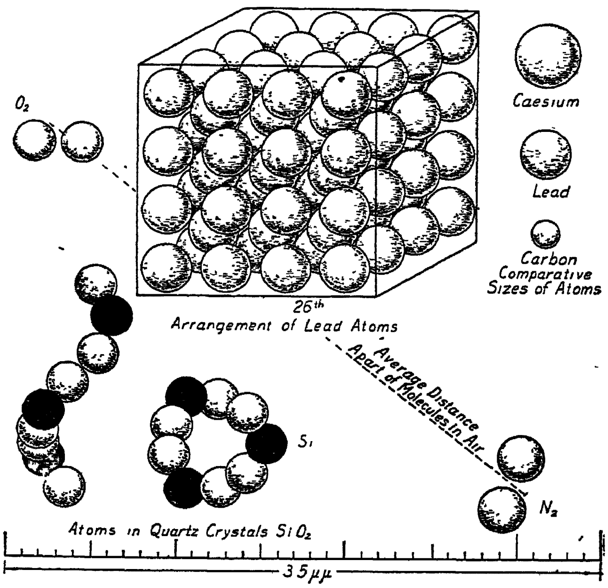

FIG. 3.—Cube 26 showing atoms with scale of reference.

Schutzenberger and then by Crookes, and that these doubts have been regarded, even up to the last few years, as speculative in the highest degree. In order to dismiss the idea that the atoms of such a familiar element as chlorine might not all be of the same weight, one had only to mention diffusion experiments and the constancy of chemical equivalents. It is only within the last few years that the lamentable weakness of such arguments has been exposed and it has been realised that the experimental separation of atoms differing from each other by so much as 10 per cent. in weight, is really an excessively difficult operation.

There are two ways by which the identity of the weights of the atoms forming an element can be tested. One is by the direct comparison of the weights of individual atoms; the other is by obtaining samples of the element from different sources or by different processes, which, although perfectly pure, do not give the same chemical atomic weight. It was by the second and less direct of these methods that it was first shown by the experiments of Soddy and others on the atomic weight of lead from different radioactive

sources, that substances could exist which, though chemically identical, had different atomic weights. These substances Soddy called "isotopes" as they occupy the same place in the periodic table of the elements.

The first experimental comparison of the weights of individual atoms was made by Sir J. J. Thomson in his analysis of positive rays by the "parabola" method. Subjected to this test most of the lighter elements appeared to follow Dalton's rule, but the results with the rare gas neon suggested the possibility of the atoms of this element being of two different weights, roughly 20 and 22 respectively. In other words the parabolas of neon indicated that it might be a mixture of isotopes, but the accuracy of measurement by this method was not sufficient to settle the point with certainty.

The requisite accuracy has been obtained by an instrument for the analysis of positive rays called the "mass-spectrograph." By this device, the weights of atoms can be compared to an accuracy of one-tenth per cent., and it has been demonstrated not only that neon (20·2) is a mixture of atoms of weights exactly 20 and 22, but also that chlorine (35·46) is a mixture of isotopic atoms of weights 35 and 37. Furthermore, about half the elements investigated turn out to be mixtures, some of the heavier ones consisting of six or more different constituents. Most important of all is the fact that every element investigated, with the exception of hydrogen, consists of atoms the weights of which are expressible as whole numbers on the oxygen scale used by chemists.

This remarkable generalisation called the "whole number rule" has removed the last obstacle in the way of the unitary theory of matter. We now have no hesitation in affirming that Nature uses the same standard bricks in the construction of the atoms of all elements, and that these standard bricks are the primordial atoms of positive and negative electricity, protons and electrons.

These are the natural unit charges of electricity, equal but of opposite sign. Of the shape of these particles we know next to nothing, but the wonderful advances of modern physics, in particular those of radioactivity, enable us to speak of their weights and dimensions with some assurance. The weight of the proton is very nearly the weight of a hydrogen atom, the electron is nearly two thousand times lighter, so that the atomic weight of an element (not consisting of isotopes) will be roughly equal to the number of protons in its atoms. The dimensions of the electron are about one hundred thousand times less than those of the atoms as illustrated above, and the proton is probably nearly two thousand times smaller still.

We now know of what atoms are constructed, and may go on to consider the evidence as to how their constituent parts are arranged. In the foregoing diagrams the atoms are represented as spheres, and in respect to the small forces and velocities which occur in the collisions between the atoms of gases at ordinary temperatures they do behave very exactly as smooth elastic spheres. But unfortunately the idea of a sphere carries the suggestion of a portion of space *full* of something; that is, the atom as a sort of spherical bag packed full of electric charges. Nothing could be further from the actuality, for from the figures already given, it can be seen at once that even in the heaviest atom known the constituent charges fail to fill even the million millionth part of its whole volume. To convey any direct idea of these numerical relations by diagrams is practically hopeless, and were we to construct a scale model of the atom as big as the dome of St. Paul's we should have some difficulty in seeing the electrons, which would be little larger than pin heads, while the protons would escape notice altogether as dust particles invisible to the unaided eye. Experimental evidence leaves us no escape from the astounding conclusion that the atom of matter, as a structure, is empty, empty as the solar system, and what we measure as its spherical boundary really only represents the limiting orbits of its outermost electrons.

The hypothesis which has led to the greatest advances in our knowledge of the inner construction of atoms is Rutherford's theory of the "nucleus atom" put forward in 1911. This is supported by so many results of direct experiment that it is now universally accepted and must be substantially correct. It postulates that all of the positive and about half of the negative electricity, that is, practically the entire weight, of the atom is concentrated at its centre, forming a very small body called the nucleus. In other words, all the protons and about half the electrons in the atom are packed together, forming a sort of sun round which revolve the remaining electrons as planets. The number of protons in excess of electrons in the nucleus will clearly be its net positive charge, and since this will not depend on the gross numbers of protons and electrons but only on their difference, we can have elements the atoms of which have nuclei of different weights but the same net charge. These are isotopes, for the chemical properties of an atom are determined by the charge on its nucleus.

The nucleus is extremely small compared with the whole atom. Thus, if in the atom of helium atomic weight 4 atomic number 2 we take the nucleus, consisting of 4 protons and 2 electrons, as represented by a rather large pea, its planetary electrons may be represented on the same scale as two rather smaller peas revolving round it at a distance of a *quarter of a mile*. The dislodgement of one of its planetary electrons from an atom requires comparatively little energy and is the well-known process called ionisation. This change is only a temporary one, as the atom takes the first opportunity of attracting it or any other stray electron back into its orbit and becoming neutral again. It is by a sort of continual exchange of such loose electrons that electricity is conducted along metallic wires. Disruption of the nucleus, on the other hand, needs enormous energy, but once performed must give rise to the atom of a new element. This process of transmutation has been achieved by Sir Ernest Rutherford, in the case of some of the lighter elements, by bombarding their atoms with alpha rays, which are charged helium nuclei expelled at enormous speeds from radioactive atoms during their natural process of disintegration. From the tiny dimensions of the nucleus compared with those of the atom it is obvious that the chance of getting a direct hit on the nucleus is only one in many millions, but the experiments show that when this does take place

protons are dislodged from the atoms of the element struck and that therefore transmutation has been actually carried out.

The quantity of matter so transmitted is indeed almost inconceivably small, but it is the first step towards what may well be the greatest achievement of the human race, the release and control of the so-called "atomic energy." We now know with certainty that four neutral hydrogen atoms weigh appreciably more than one neutral helium atom, though they contain identically the same units, 4 protons and 4 electrons. The change of weight is probably due to the closer "packing" in the helium nucleus, but whatever the explanation may be transmutation of hydrogen into helium must inevitably destroy matter and therefore liberate energy. The quantity of energy can be calculated and is prodigious beyond the dreams of scientific fiction. If we could transmute the hydrogen contained in one pint of water the energy so liberated would be sufficient to propel the *Mauretania* across the Atlantic and back at full speed. With such vast stores of energy at our disposal there would be literally no limit to the material achievements of the human race.

The possibility that the process of transmutation might be beyond control and result in the detonation of all the water on the earth at once is an interesting one, since, in that case, the earth and its inhabitants would be dissipated into space as a new star, but the probability of such a catastrophe is too remote to be considered seriously. A recent newspaper article pointed out the danger of scientific discovery, and actually suggested that any results of research which might lead to the liberation of atomic energy should be suppressed. So, doubtless, the more elderly and apelike of our prehistoric ancestors grumbled at the innovation of cooked food, and gravely pointed out the terrible dangers of the newly-invented agency, fire, but it can scarcely be maintained to-day that subsequent history has justified their caution.

The Herring Fishery and its Fluctuations.

By B. STORROW, Dove Marine Laboratory, Cullercoats, Northumberland.

HERRINGS are fished in every month of the year, and the catches show considerable variation in the size of the fish, the state of the reproductive organs, and the age composition of the shoals. It is necessary, therefore, before arriving at any conclusion with regard to the fishery, to take into consideration the kinds of herrings which are caught on the different grounds throughout the year.

In the beginning of the year, January, February, and March, shoals are fished about the north-west of Ireland, off the north of Scotland, including the Shetlands and Orkneys, and in the Firth of Forth. These herrings are all fish with the gonads well developed, and they spawn towards the end of February or in March. They are known as spring spawners and, except for the shoals of the Firth of Forth, they, so far as the western part of the North Sea is concerned, are caught in northern waters. In April the spent fish from the spring spawning shoals are caught all over the North Sea, from the Shetlands to Bergen Bank, from North Shields to the Naze, and off Yarmouth and Lowestoft. The catches are used chiefly for bait by the drift-net fishermen, who at this time are fishing with lines for cod, ling, halibut, etc. Among some of the bait catches are found numbers of small fish with the gonads not developed, and without doubt these can be classified as virgin fish.

During May the number of drifter-liners decreases and catches of herrings are made from ten to thirty miles off our coast. These catches consist of young fish with the gonads at practically the same stage of development as those found in catches made in April, 100 miles from the nearest port, and when, for the offshore and inshore fish, the growth as calculated from the scales is compared, the agreement warrants the conclusion that the young fish have moved shoreward from the deeper waters. In good seasons this movement towards the shore coincides with increased landings of herrings.

Throughout June waves of migrating herrings come on to the grounds, and in the beginning of July the migrations are large enough to bring about a considerable increase in the fishery. These June and early July migrants have been found, off the Northumberland coast, to be marked with a comparatively small first-year growth, as determined from the scales, which, for the most part, show three winter rings. Recovering spents from spring spawning shoals are found among catches of young developing herrings, but after the beginning of July they disappear, or the numbers found are insignificant.

Herrings with three winter rings and with a comparatively larger first-year growth than the June fish invade the grounds during July and August and give the high catches which are taken in these months in a successful fishery. Towards the end of August and the beginning of September shoals of larger and older herrings appear. They are full fish with their reproductive organs developed, and they, together with the young herrings sufficiently developed, form autumn spawning shoals. After spawning they disappear quickly and only young fish are to be caught.

The summer fishery of the east coast, the Shetlands excluded, is one which depends chiefly on young fish, and samples examined from Wick to Scarborough have been found to contain from 50 to 70 per cent. of fish with three winter rings on their scales. Fish of this age, therefore, determine the productivity of the fishery.

In September herrings are caught in the vicinity of the Dogger Bank by Dutch luggers and by trawlers, off Scarborough and Grimsby by drift-nets. Some of these fish are autumn spawners, but some, especially those caught by trawlers, are spring spawners, which now make their reappearance in great numbers. An examination of catches made on these grounds points to the herrings coming from the north-east to the south-western end of the Dogger Bank and then moving in a south-westerly direction to the Grimsby grounds.

The East Anglian harvest begins in September and continues to the beginning of December. In the early part of the fishery many of the catches are landed from the grounds off Grimsby and it is not until October that the large fleets concentrate off Yarmouth and Lowestoft. This fishery is essentially one for full

herrings and, although small numbers of spawning fish and spents are caught, the bulk of the catches consists of fish which will become spring spawners. The herrings are of all ages, from fish with three winter rings to those with as many as nine or ten, and the samples obtained from these shoals point to the older fish being the latest migrants.

The herring fishery of the southern part of the North Sea differs from that of the east coast in that it depends for its success upon the presence of older and adult fish. In this respect it is like the fishery in northern waters about the Shetlands. But both these fisheries must receive additions from the summer shoals of developing fish if they are to continue in existence, and the question of their productivity cannot be considered without reference to the younger shoals.

For other waters we have not the same quantity of data as we have for the North Sea. In the Minch and off the north-west of Ireland there are spring and autumn spawners and summer shoals of developing fish. In the Irish Sea the summer feeding shoals are followed by autumn spawners, but for these waters, owing to the large numbers of herrings with two winter rings found in the catches of 1921, further investigations are required before a definite statement can be made as to the age when the young fish join commercial shoals in greatest numbers.

The poor summer fishery of 1920 and its failure in 1921 can be accounted for by a shortage of fish with three winter rings and belonging to the year-classes of 1917 and 1918. For an explanation of the poor catches from shoals of adult herrings a consideration of their age composition is necessary. Samples examined in 1919, 1920, 1921, and the spring of 1922, and obtained not only from the East Anglian shoals but from the north-west of Ireland and the north of Scotland, have contained large numbers of fish of the 1913 and 1914 year-classes. In all samples the year-class of 1915 has been poorly represented. The year-class of 1916, which gave the fairly successful summer fishery of 1919 when the young fish had then three winter rings, can be considered a good but not a rich year-class. The older herrings have naturally decreased in numbers and the samples and catches obtained from shoals of adult fish give no indication that a rich year-class of young herrings has joined these shoals.

While a consideration of the age composition of the shoals leads to the conclusion that the failure of the fishery is due to the relative value of the different year-classes it indicates also that the migrations have had some effect. Although we know little about the migrations of the herring, there appears to be no doubt that the migrations of the fish which have become adult and joined spawning shoals differ from those of the young which have not yet spawned. In the spring of 1921 comparatively large numbers of young herrings with three growth areas on the scales were found as full fish among the samples from the north of Scotland and the Firth of Forth. Further sampling in 1922 has confirmed the finding of the previous year. Now, fish of this age in the spring of the year are those which, in June, July, and August, determine the yield from the summer fishery. Since large numbers of them had spawned in the spring of 1921, and afterwards would migrate as adult fish, the summer fishery of that year was poorer by reason of their absence. The high catches made this year from the waters about the Shetlands came, in part, from grounds which have been unproductive for a number of years, and they point to migrations which we know have followed the activity of Atlantic waters and herrings reaching maturity at an early age.

The age composition of the adult shoals fished off the north-west of Ireland, the north of Scotland, and in the southern North Sea, does not permit of the idea that the conditions which govern the fishery occur in small areas only. A consideration of the 1904 year-class from data accumulated by Hjort and Lea gives some idea of the widespread nature of the factors which produce good year-classes. In the southern waters of the Gulf of St. Lawrence the year-class of 1903 was found to predominate, and that of 1904 in the northern waters of the Gulf. The same year-class was the mainstay of the Norwegian fishery for a number of years and was rich in Icelandic waters. The large catches on the east coast of Scotland in 1907 can be referred to the 1904 year-class, and so can the good fisheries of the English Channel in 1909 and 1910. The conditions producing good year-classes extend over the greater part of the North Atlantic area. The difference between the north-west of Ireland fishery and that of the North Sea in 1909 and 1910 suggests that in some years, *e.g.* 1905, the factors which govern year-classes may move along the west coast of Ireland towards the North Sea. The age composition of the shoals in 1919–1921 indicates the coincidence of conditions over the area north-west of Ireland north into the North Sea. That variations in oceanic circulation may bring about local changes in the fishery would appear from the failure of the Firth of Clyde fishery, 1904–1920, and that of the west of the Shetlands, 1905–1922. The disappearance of young herrings from the Wash points to the same conclusion.

To say that fluctuations in the herring fishery have been observed since the beginning of the fishery is to make a statement incapable of proof but one which is extremely probable. The history of the fishery, so far as we know it, consists of a series of fluctuations, and the attempts to account for these have given rise to explanations which have varied from the conditions of the year of capture to the wickedness of the people.

However ridiculous some of these old opinions may appear, it is only since Norwegian investigators, Hjort, Dahl, and Lea, directed attention to the scales of the herring that we have had any definite knowledge of the age composition of some of the herring shoals. Few people think of herrings in their fourth year as being of greatest importance in our summer shoals; a still smaller number think of the conditions of the year of hatching as being the factor which determines good and poor year-classes. Evidence recently examined points to this view requiring some modification and to the possibility that the conditions of the year preceding hatching are the dominant factor in the production of good year-classes. Whatever modification may be needed for this latest idea will depend on the knowledge we hope will be obtained of the life of the herring before it enters the commercial shoals.

That the conditions preceding hatching are of greatest importance is indicated by some of the results obtained when this has been taken as a working hypothesis and

a period of four years allowed between hydrographic phenomena and herring catches. For a period of fifty years it has been possible to show a relation between the range of tide at Aberdeen and the productivity of the herring fishery of the east coast of Scotland. The curves representing tidal data and herring catches show periods in which they tend to parallelism and to convergency, but until this periodicity is understood and can be foreseen the result will be of little use commercially. Good year-classes can be referred to the activities of Atlantic water, which have been shown by Pettersson to depend upon the periodic variation of lunar influence, but more definite knowledge is required as to the time, intensity, and direction of invasions of Atlantic water into the North Sea. This is particularly illustrated by the conditions which are held to have produced the 1907 year-class, which gave the rich fishery on the east coast of Scotland in 1910. The wide-spread occurrence of the rich year-class of 1904 which was found in the Gulf of St. Lawrence and in practically all waters of north-west Europe suggests that a study of the hydrographic conditions of the North Sea alone is insufficient for a full understanding of the factors which determine the wealth of the different year-classes.

Although the production of good year-classes has the greatest influence on the fishery in that these year-classes give a herring population sufficiently large to yield a succession of large catches throughout the season, or a number of seasons, the migrations of the herrings have an effect which is considerable and they may in some cases bring about the formation of new fisheries or the non-existence of others. Pettersson has shown how the great Baltic herring fishery of the Middle Ages coincided with a maximum activity of Atlantic waters, due to the greatest possible tidal influence of the moon and sun, and, also how the present Baltic fishery fluctuates in a period of eighteen to nineteen years. These fluctuations are noticeable chiefly in shoals of adult fish, and, in our waters, for the shoals off East Anglia and the winter herrings of the east coast of Scotland, they have been found to alternate with those of the Baltic fishery. The composition and nature of the shoals about the Shetlands this year point to migrations which have followed the most recent invasion of Atlantic waters, with which has coincided the lateness of the appearance of the Northumberland July shoals in 1920 and 1921 and of the shoals fished from Yarmouth in September 1921. Before we can hope to understand this periodicity in migrations and the difference from year to year in the arrival of our shoals a much more comprehensive knowledge of the hydrography of the North Sea and of the factors controlling the movements of the waters of the North Atlantic is required. Further, the publication of the statistics relating to the fishery in a form which will allow of their examination as to where and when the catches were made is desirable.

That the poor quality of the herrings and the early maturity of the younger year-classes have coincided with one another and with the presence of large quantities of Atlantic water cannot be taken as solving the problem of their occurrence. Neither does the poor liver yield from Norwegian cod, which, in some years at least, coincided with large numbers of young fish among adult cod and with Atlantic water activity, throw any further light on what must be regarded as a physiological problem awaiting investigation, and one which cannot be considered as explained by a reference to a possible scarcity of copepods.

The problem of the fluctuations in our herring fishery is not one which can be solved by a consideration of one or two isolated set of phenomena. That the activity of Atlantic water has a connexion with periodicity in the fishery and with the production of good year-classes suggests a possible way of approach. It is a problem which demands the attention not only of the zoologist and the hydrographer, but also of the physiologist and probably that of the astronomer. Further, it must not be forgotten that the men engaged in the fishery and the industries connected therewith are concerned more about the fluctuations from year to year than those which are spread over much longer periods.

The Nebraska Tooth.

By W. P. PYCRAFT.

AT the meeting of the Zoological Society on November 7, Prof. Elliot Smith exhibited a cast of the now famous Nebraska tooth, which is regarded by American palæontologists as representing a new genus and species of the human race—*Hesperopithecus haroldcooki*. This tooth—a "second upper molar" —differs, we are assured, on one hand from that of any known anthropoid apes, and on the other from any of the primitive types of man yet discovered.

Prof. Elliot Smith is in agreement with this interpretation; and presented fresh evidence in its support, furnished him by Prof. Osborn. This evidence included the results of radiographing the tooth, together with the teeth of a chimpanzee and Piltdown man. But these, it must be admitted, were unconvincing pictures, since they failed to demonstrate the features they were designed to show.

The teeth of the Piltdown man, it will be remembered, showed a large pulp-cavity placed above the level of the alveolar border of the jaw, as in modern man; wherein, however, the cavity is smaller. But the Piltdown teeth, in this regard, differ as much from the teeth of Neanderthal man, wherein the pulp-cavity was of great size, and evidently developed at the expense of the roots. Sir Arthur Keith has called such teeth "taurodont." They are peculiar to men of the Neanderthal type. The Piltdown teeth, like those of the modern man, are of the "cynodont" type. This fact, it may be predicted, will come to have an additional significance in the near future.

Dr. A. Smith Woodward, in the discussion which followed Prof. Elliot Smith's remarks, reaffirmed his original belief—expressed at the time when the discovery of the Nebraska tooth was first announced, and set forth in NATURE of June 10 (vol. 109, p. 750)—that this tooth was more probably that of one of the primitive, extinct bears (Hyænarctos), than of some primitive member of the primates. Prof. Osborn

dismisses this suggestion on the ground that "the difference is so fundamental that it is difficult to find any single point of agreement." But from Prof. Osborn's own account of this tooth, which appeared in NATURE of August 26, p. 281, it is a no less difficult matter to discover harmony between this tooth and the molars of any of the primates, living or extinct. We cannot escape the conclusion, in short, that the evidence as to the true character of the Nebraska tooth has been only partly sifted. Before we can consider ourselves in possession of the whole of the evidence it must be carefully compared with *worn* teeth of Hyænarctos, and its near allies. Radiographs of such teeth are essential. For the moment the material for such a comparison is, doubtless, limited: but even this can, and must, be taken into account. We trust that Prof. Osborn will see his way to supplement the able summary he gave us in NATURE, in August last, wherein he contrasts the tooth of Hesperopithecus with the teeth of chimpanzee and Pithecanthropus, by a similar pictorial comparison between this remarkable tooth and the teeth of the fossil bears, or at least a Hyænarctos.

The extremely worn condition of this tooth compels caution in every statement made concerning it: and more especially on the part of those who have never seen and handled the actual specimen. The danger of dogmatising on the evidence afforded by photography and casts alone, was forcibly illustrated in the case of the skull of Piltdown man. But it is also imperatively necessary, in the interests of science, that even remotely possible relationships should be seriously examined. It is always unwise to assume that what *ought* to be, *must* be. We cannot help feeling that this applies very pertinently in the case of the Nebraska tooth: and that therefore it would be wise at any rate to entertain the *suggestion*, that it may, after all, represent one of the Ursidæ, instead of one of the Hominidæ.

Obituary.

MRS. A. D. WALLER.

THE announcement of the death on October 22, at sixty-three years of age, of Mrs. Waller, widow of the late Dr. A. D. Waller, must have been noticed with regret by many workers in the world of science. Alice Mary Palmer, which was Mrs. Waller's maiden name, had early aspirations towards a medical career, and after matriculating in the University of London she took up her medical course at the London School of Medicine, where she became the pupil of Dr. Augustus Waller, then lecturer in physiology at the School. Miss Palmer was appointed his demonstrator—a post which she filled with enthusiasm. His original and stimulating lectures were a great delight to her, and the relationship of teacher and pupil ripened rapidly into a closer one.

Husband and wife had much in common: both cared intensely for education and worked throughout their lives for what they considered its best interests. After her marriage Mrs. Waller's chief concern was for her husband's work. In all that he did she had her part; she enjoyed the whole technique of laboratory work, owning apologetically that even a bit of "mere" anatomy never came amiss to her. The house in Grove End Road, which soon became such a centre for scientific interests, was secured for the young couple early in their married life. It was an unusual household, being at once both laboratory and home, and its ways were unconventional; but to those who caught the spirit of the place, the charm of its hospitality was irresistible. All who cared for scientific work were welcomed there, and to the student who sought her advice Mrs. Waller became at once friend, champion, and helper. Foreign friends, distinguished and undistinguished, made Weston Lodge their resting-place when visiting London, and much good talk was heard within the walls of the old study—great were the discussions, vigorous the arguments, and over all debates played the gentle humour of the hostess, softening the sometimes mordant wit of her husband.

During the latter years of their lives the centre of interest was transferred, for the Wallers, from Weston Lodge to the University Laboratory at South Kensington. That laboratory fulfilled to a large extent the purpose for which it was founded. Many will remember it as a place of help, inspiration, and fruitful work, and it may safely be said that there are none who ever worked there but will remember with affectionate gratitude the gentle woman who cared so greatly for the destinies of the laboratory and for the welfare of each of its individual workers.

LADY HERDMAN.

IN educational and scientific circles widespread sympathy is felt with Sir William Herdman at the death of Lady Herdman on November 7. His loss is shared by all who knew Lady Herdman, as well as by many others to whom her life and work were both a stimulus and a standard. Lady Herdman was a daughter of the late Mr. Alfred Holt, and was a student at University College, Liverpool, when Sir William Herdman was professor of natural history there. She graduated in science at London University in 1891, with first-class honours in physics, and in the following year became the first president of the Women Students' Representative Council at Liverpool. She was thus an active worker in the University College of the city before it became the University of Liverpool in 1903; and in promoting this development, as well as since, Lady Herdman was closely associated with her distinguished husband. The scientific world gratefully remembers how in 1916, in commemoration of the death of their brilliant son George in the battle of the Somme, they gave the sum of 10,000*l.* to the university for the foundation of the George Herdman chair of geology, and three years later founded and endowed the chair of oceanography in the university. In these and many other ways, as, for example, by devoted service on the Liverpool Education Committee, of which she was a co-opted member, Lady Herdman exercised an influence which was always beneficial and often more far-reaching than she herself ever conceived. She possessed wisdom as well as knowledge, and the remembrance of her life will long be cherished with affection, to console as well as to inspire.

Current Topics and Events.

THE presence of the Prince of Wales at the dinner arranged by the Institution of Mining Engineers and the Institution of Mining and Metallurgy at the Guildhall, London, on November 16, gave Royal distinction to a memorable occasion in the history of applied science in this country. The Prince himself, in his tribute to the mining engineer, referred with particular approval to the amalgamation of the two institutions and remarked: " I cannot help feeling that there are in this country many institutions, scientific and otherwise, which might do well to follow your example, and, as you have done, group themselves round a joint secretariat and library, housed in a single building." The combined membership of the two institutions is more than 6300, and the two councils have decided to invite the sister-institutions in the British Isles and the Dominions to co-operate with them as equal partners in the constitution of an Empire Council of Mining and Metallurgical Engineering Institutions. Sir John Cadman, president of the Institution of Mining Engineers, who presided at the dinner and was associated with Mr. S. J. Speak, president of the Institution of Mining and Metallurgy, in referring to this new body linking up members of the mining profession throughout the British Empire in a concerted effort of practical achievement, expressed to the American Ambassador, who was present, the hope that such a scheme would find favour in the United States and ultimately embrace all English-speaking mining and metallurgical engineers. The importance which the Institution of Mining and Metallurgy attaches to technological education was shown by the presentation of the gold medal of the institution to Sir Alfred Keogh, who has just retired from the Rectorship of the Imperial College of Science and Technology. Sir George Beilby was similarly presented with the medal of the Institution of Mining Engineers in recognition of his contributions to science, with particular reference to his researches on fuel; both recipients had the honour of receiving the medals from the hands of the Prince of Wales. The speeches at the dinner were of a remarkably high order, and we offer our congratulations to all who were concerned in making arrangements for an event which not only maintained the dignity of applied science but also will contribute in no small measure to its continued development.

THE latest reports add little to our knowledge of the Chilian earthquake except to increase the estimates of the loss of life and of the destruction of property. The total number of deaths is for the present officially put at 1800, and that of the injured at more than two thousand. The town which seems to have suffered most is Vallenar, half-way between Coquimbo and Copiapo and about forty miles from the coast, where one out of every eight inhabitants was killed. Much of the damage, especially from Coquimbo to Chanaral (240 miles north of Coquimbo) was caused by the sea-waves. The early and clearly erroneous report that the depth of the sea near Copiapo had decreased from 2800 to 86 fathoms is now contradicted. The greatest known uplift is less than 48 feet, in Alaska during the earthquakes of 1899. M. de Montessus de Ballore, who has studied the distribution of the Chilian earthquakes, defines several regions along the coast. The region of Atacama, Copiapo, and Coquimbo, to which the recent earthquake belongs, is one in which earthquakes are relatively frequent, though it is less often visited by destructive shocks than the regions of Arica and Iquique, and of Valparaiso, Santiago, and Concepcion. All three regions are situated in a district of unusually steep surface-gradient. Off Arica lies the Bartholomew deep (3500 fathoms), off Copiapo the Richards deep (4100 fathoms), and off Valparaiso the Haeckel deep (3000 fathoms). The origin of the recent earthquake may have been near the southern end of the Richards deep.

THE *Electrical Review* is to be congratulated on the issue of its jubilee number. It may well be proud of its record during the last fifty years. It has taken a broad view of its technical functions and has published many important papers in pure and applied science. This jubilee number is a particularly interesting one, as the articles are written more with an eye to the future than the past. Electricians regard a cheap unit of electricity as the most essential raw material for the country. There are endless duties which electric power can perform, not only in our homes and factories but on our railways and in mines. It is possible that the advent of the thermionic valve may lead to the scrapping of the telephone system of the country. Major Purves, the Engineer-in-Chief of the Post Office, looks forward to the possibility of an entire change in our methods of telegraphy. Telegrams can be despatched by the photographic means already shown to be feasible for the transmission of drawings and photographs. These messages would be charged by the area of the paper occupied by the telegram and not by the number of words. The received telegram would be a facsimile of the original and neither counting of words nor corrections would be required. Sending telegrams would be almost as simple as sending letters, and would be much quicker and less costly than at present. The advantages of electric heating are also emphasised. When this system is adopted chimneys in buildings can be dispensed with, fireplace furnishings will be unnecessary, and the inlet and outlet ventilators on the floor and ceiling of the room will give the occupant a better control over the air supply.

THE words " Leaf Pictures " recall the ingenious arrangements of pressed seaweeds, shells, and the like still to be found adorning the walls of modest dwellings in the country. The work exhibited by Mr. W. J. King at 118 New Bond Street is of a very different order, and challenges the attention alike of the man of science and the lover of art. As the botanist turns from the plant materials employed to the finished product, he cannot but marvel at the delicacy of perception required in the selection of the

former and the degree of technical skill shown in elaborating an entirely original technique. Some of the work dates from twenty years back and suggests problems to the plant physiologist on the stability of vegetable pigments in relation to light and other external conditions. Seen at a little distance, the pictures might be mistaken for oil paintings. Actually, the medium consists of plant material—leaves, petals, and other tissues—selected with much skill and exposed to bright sunshine after drying. The material so prepared is treated as would be the colours on a palette, and by its use in this way Mr. King has achieved remarkable results. The " Dante bust " (Naples) and the " Virgin " (after Bernardino Luini) afford proof of the technical skill of the craftsman. The original works, especially the landscapes entitled " Spring," " Beech Trees in Autumn," and others, provide evidence of real artistic ability as well as mastery of a most remarkable plastic medium.

DR. GRAVELY, the superintendent, seems determined to make the Government Museum, Madras, used by the local schools. He has attached the scientific and popular names in various vernaculars to the trees in the compound; he has started a herbarium of the flora of Madras city, also with vernacular names, as a guide and ensample to the schools; he has had a research student of the University of Madras working on the local fauna with special reference to groups likely to be useful for nature study (bugs are specially mentioned); and he has arranged for demonstrations both to teachers and to students. Alas! Madras does not respond as it ought: one out of the four demonstrations to teachers failed because no teachers turned up, and of the 2221 anticipated students only 950 attended. But Dr. Gravely goes on collecting the local specimens, and his sub-librarian has at any rate found matter for a chapter on " Museums and Libraries " contributed to a work on " Teaching in Indian Elementary Schools." All of which and much more we learn from the Report entitled G.O. No. 885.

DR. J. C. WILLIS has published in the *Nineteenth Century* for October a statement of his hypothesis of " Age and Area," in its bearing on the evolution of species. It will be remembered that the subject was introduced by him at the recent meeting in Hull of the British Association, where it met with somewhat severe criticism. In the present article the author avers that Darwin's theory of natural selection " has received so severe a shake that it is no longer a name to conjure with." It is unable, for example, to explain the distribution of the Ceylon species of the genus Coleus (nettle-geranium). The visible structural differences between the species of wide and those of restricted distribution cannot possibly make any difference of advantage or disadvantage to their possessor. The controlling principle, according to Dr. Willis, is that " widely-spread species are in general the oldest and first evolved, very local species the youngest and last evolved." Moreover, the area occupied by a group of genera corresponds roughly with the number of species in each genus of the group. It follows that the number of species in a genus should also show an increase with its age. Opinions will differ as to the importance to be assigned to the factors suggested by Dr. Willis; it cannot, however, escape notice that while he alleges that it would be " wiser to abandon natural selection " as the general principle that has guided evolution, he yet allows that " nothing can come into lasting existence " without its permission.

THE opening remarks of Prof. C. H. Desch in his Streatfeild Memorial Lecture delivered at Finsbury Technical College on November 2, on the subject of " The Metallurgical Chemist," emphasised the value of trained chemists in the field of metallurgical and chemical industry to control and guide these industries. Prof. Desch asserted that the basis of the training for a metallurgical chemist should be mathematics, physics, and chemistry, and specialised work should not be entered upon at too early a stage. Chemical knowledge and manipulative skill is required, for example, for the analysis of alloys and modern high-speed steels, while training in physical chemistry and physics is requisite for a proper interpretation of the results of examinations of physical properties, for example, of alloys as shown by X-ray analyses. There is also need for engineering knowledge for carrying out large-scale metallurgical operations, such as the study of fatigue and also in ore extraction. Probably the best results can be obtained by the co-operation of chemist and engineer both with a certain amount of training in common. Prof. Desch also referred to the importance to the metallurgical industries of further work on refractory materials. Another matter awaiting immediate attention is economy in the utilisation of fuel and other natural resources. Secrecy and rule-of-thumb methods have completely disappeared from the steel industry, and co-operation between the scientific advisers, to the advantage of the whole industry, has taken its place.

ON November 15, Prof. A. P. Laurie, professor of chemistry to the Royal Academy, delivered a lecture at the Academy on " The Preservation and Cleaning of Pictures." He pointed out that the question of the preservation and cleaning of pictures is not a purely scientific one, but involves certain æsthetic considerations, and he suggested that there has been some confusion of thought on the whole subject. A picture might have certain flakes of paint off it, and yet be otherwise in good condition, and in such a case it would probably be considered necessary to restore the absent pigment. Here, however, we get upon purely æsthetic ground as to whether such a restoration is justifiable. In order that the general appearance of the picture conveyed to the observer what the artist intended, it is necessary to replace the defective part, but from the point of view of the minute and careful student of the picture, it is essential that such replacement should be known. This difficulty can be overcome by taking photographs of the picture before repair, so as to put on record what is the work of the master and what is the work

of the restorer. While not prepared to give a final opinion as to the safest methods of cleaning, Prof. Laurie suggested that where alcohol is used castor-oil should be laid on the surface with a soft brush, and then a mixture of castor-oil and alcohol dabbed on with a soft brush, and removed by diluting with turpentine and sopping up with a large dry brush. Where alcohol is not a sufficiently powerful solvent copaiba balsam emulsified with ammonia might be used, a preparation of copaiba balsam thinned with a little turpentine being laid on the surface first. If any friction is to be applied it should be done with a soft rubber point, and at every stage examined under a powerful magnifying glass. No important public picture should be cleaned until it has been authorised by a committee of experts, and the cleaner himself should be present and explain exactly what he is going to do, while everything he does should be under the direct supervision of the head of the Public Gallery.

THE next Congress of the Royal Sanitary Institute will be held at Hull on July 30-August 4, 1923, by invitation of the Mayor and Town Council.

THE Huxley Memorial Lecture announced for delivery by Prof. M. Boule at the Royal Anthropological Institute on Tuesday, November 28, has been postponed through the ill-health of the lecturer and his consequent absence from this country.

APPLICATIONS are invited for the Government Grant for Scientific Investigations for the year 1923. They must be received at the offices of the Royal Society, Burlington House, Piccadilly, W.1, by, at latest, January 1, on forms obtainable from the clerk to the Government Grant Committee.

NOTICE is given by the Chemical Society that the latest date for the receipt of applications for grants from the Research Fund of the Society is Friday, December 1. The applications must be made upon forms obtainable from the Assistant Secretary, Chemical Society, Burlington House, W.1.

THE Hon. Sir Charles A. Parsons has consented to deliver the second Joule memorial lecture at the Manchester Literary and Philosophical Society's house on Tuesday, December 5, at 4 P.M. The title of the lecture will be "The Rise of Motive Power and the Work of Joule." The dinner, in honour of the lecturer, will be held the same evening at 7.30 P.M.

IN our obituary notice of Prof. Michie Smith (November 4, p. 610), the initiative in the establishment of the mountain observatory near Kodaikanal was ascribed to him. Mr. F. Fawcett writes that it was really due to his predecessor, Mr. W. Pogson, who had this project much at heart; but his premature death prevented him from seeing its realisation.

THE eleventh International Physiological Congress will be held in Edinburgh on July 23-27, 1923. The following officers for the meeting have been elected: President, Sir Edward Sharpey Schafer; treasurer, Prof. A. R. Cushny; secretaries, Prof. G. Barger and Prof. J. C. Meakins; assistant secretary, Miss Dorothy Charlton. Further particulars can be obtained from the assistant secretary at the Department of Physiology, The University, Edinburgh.

AT the annual general meeting of the London Mathematical Society on November 9, the following officers and members of council were elected:—*President*: Prof. W. H. Young; *Vice-Presidents*: Mr. A. L. Dixon, Prof. A. E. Jolliffe, and Mr. H. W. Richmond; *Treasurer*: Dr. A. E. Western; *Secretaries*: Prof. G. H. Hardy and Prof. G. N. Watson; *Other Members of Council*: Mr. J. E. Campbell, Prof. L. N. G. Filon, Prof. H. Hilton, Miss H. P. Hudson, Mr. J. E. Littlewood, Prof. A. E. H. Love, Mr. E. A. Milne, Mr. L. J. Mordell, and Mr. F. B. Pidduck.

A CONFERENCE in classical archæology will be held at Oxford, with the sanction of the committee for Classical Archæology, in the Ashmolean Museum, on January 9-16, 1923. There will be lectures, discussions, and demonstrations concerning Greek and Roman monuments and antiquities. The conference, which is intended mainly for those engaged in teaching, will take place only if a satisfactory number of applications for membership is received by the Hon. Secretary, Mr. Stanley Casson, New College, Oxford, before the end of this month.

BY the will of Mr. W. H. Hudson, who died on August 18 last at the age of eighty years, the residue of his property, more than 7500*l*., is bequeathed to the Royal Society for the Protection of Birds "to be used exclusively for the purpose of procuring and printing leaflets and short pamphlets suitable for the reading of children in village schools . . . each is to be illustrated with a coloured figure of a bird, the writing is to be not so much 'educative' or 'informative' as 'anecdotal.'"

THE Institution of Naval Architects is offering the following scholarships for competition in 1923:—In naval architecture—Martell (130*l*. per annum), Hawthorn Leslie (150*l*. per annum), Vickers (150*l*. per annum), John Samuel White (100*l*. per annum), Denny (75*l*. per annum); and in marine engineering—Richardson Westgarth (150*l*. per annum), Denny (75*l*. per annum). The scholarships are open to British apprentices or students, and are tenable for three years at the following institutions: the Universities of Glasgow, Durham (Armstrong College), and Liverpool, the Royal Naval College (Greenwich), and the City and Guilds (Engineering) College, London. Full particulars may be obtained from the Secretary, Institution of Naval Architects, 5 Adelphi Terrace, London, W.C.2.

THE October number of the Journal of the Royal Photographic Society is a special exhibition number. It includes the address given by Mr. Solomon J. Solomon when he opened the Society's exhibition, descriptive notices of the various sections, and reproductions of about thirty of the exhibits, several of which are from the natural history and scientific sections. It forms a distinctly valuable and interesting addition to the catalogue, which also contains several reproductions.

THE latest catalogue of second-hand books offered for sale by Mr. F. Edwards, 83 High Street, Marylebone, W.1, is No. 437 (November). It gives the titles, and in many cases descriptions, of upwards of 800 volumes on oriental matters, mainly Chinese and Japanese.

THE old-established firms of instrument-makers, T. Cooke and Sons, Ltd., of London, York, and Cape Town, and Troughton and Simms, Ltd., of London and Charlton, have amalgamated, and the joint business will be conducted under the name of Cooke, Troughton and Simms, Ltd.

WE have received from Messrs. A. Gallenkamp and Co., Ltd., of 19 and 21 Sun Street, Finsbury Square, London, E.C.2, Part I. of the seventh edition of their catalogue of general chemical apparatus, including balances and weights. In addition to the ordinary requirements of the chemical laboratory, the catalogue includes some special features such as Mellor's porosity apparatus and a series of vacuum drying ovens.

THE "Collected Scientific Papers" by the late Dr. John Aitken, the final sheets of which were passed for press by Dr. C. G. Knott just before his death, will shortly be published by the Cambridge University Press. The volume will contain a biographical sketch of the author. "The Theory of Spectra and Atomic Constitutions," by Prof. Niels Bohr, will also be published by the Press in the near future. It is based on lectures delivered in Cambridge and deals with the application of the quantum theory to problems of atomic structure.

Our Astronomical Column.

THE LEONID METEOR SHOWER.—Mr. W. F. Denning writes that "The nights of November 13 and 15 were alone suitable for observation at the period of the Leonid display this year, and very few meteors appeared. Mr. J. P. M. Prentice watched the heavens on the night of November 15 between 5.45 and 12.45 and recorded only 44 meteors during the seven hours, of which three were Leonids. At Bristol the sky was watched at a later hour, but only one Leonid was seen between 13^h and $13^h\ 45^m$, after which observations were discontinued. Mr. Prentice noticed several minor showers of which radiant points at $41°+29°$, $42°+21°$, $53°+13°$, and $55°+84°$ were the most actively pronounced." The shower of Leonids was not expected to be abundant this year, as the parent comet (1866 I) will not return until 1933. It sometimes happens, however, that a moderately active display of Leonids occurs when the comet is far removed from perihelion, as in 1879 and 1888.

COMET NOTES.—Baade's Comet, 1922 *c*, was observed at Copenhagen on November 9 and at Cambridge by Mr. G. Merton, using the Northumberland Equatorial, on November 11. It has a fairly definite nucleus 10″ to 20″ in diameter, and a coma $1\frac{1}{2}'$ in diameter. The stellar magnitude is variously estimated at 9 and 10·5, the former being probably nearer the truth. The brightness is slowly diminishing, but the comet should be observable for some months. The following orbit is from observations on October 19, 28, November 11 :—

$$T = 1922 \text{ Oct. } 27{\cdot}252 \text{ G.M.T.}$$
$$\left.\begin{aligned}\omega &= 118°\ 46'{\cdot}3\\ \Omega &= 220°\ 34'{\cdot}2\\ i &= 51°\ 22'{\cdot}3\end{aligned}\right\}1922{\cdot}0.$$
$$\log q = 0{\cdot}35318.$$

EPHEMERIS FOR GREENWICH MIDNIGHT.

	R.A. h.	m.	s.	N. Decl.		log r.	log Δ.
Nov. 25.	21	15	32	27°	20′	0·3579	0·3150
29.	21	25	36	26	20	0·3593	0·3222
Dec. 3.	21	35	39	25	21	0·3608	0·3297
7.	21	45	39	24	26	0·3625	0·3377
11.	21	55	35	23	33	0·3643	0·3460
15.	22	5	27	22	44	0·3663	0·3549

The comet is well placed in the evening sky, high up in the south-west; it is visible in moderate telescopes. The above path begins 3° S.E. of ζ Cygni, and ends 3° S. of ι Pegesi. It is important to observe it as long as possible, in order to detect any deviation from a parabola.

Mr. F. E. Seagrave has computed the two following orbits of Comet Pons-Winnecke from observations made respectively before and after perihelion passage in 1921 :—

T =	1921 June 12·9165.	June 12·9276.
ω =	170° 17′ 18″.	170° 15′ 56″.
Ω =	98° 6′ 29″.	98° 8′ 19″.
i =	18° 54′ 37″.	18° 56′ 33″.
log q =	0·017372.	0·017409.
μ =	592″·888.	587″·184.
Period =	2185·9 days.	2207·1 days.

The next perihelion passage will be in June 1927. The conditions will be very similar to those in 1921, but the approach to the earth will probably be closer; search should again be made for meteors in that year, since these are evidently spread fairly widely around the comet's orbit. The perturbations in the present revolution are small, there being no approach to Jupiter.

REPORT OF THE PARIS OBSERVATORY FOR 1921.—This report shows that in spite of difficulties caused by the war there is quite a large output of work. The observations for three important star catalogues have been completed, namely, (1) The supplementary catalogue of Lalande stars; (2) tnat of 15,000 *étoiles de repère* of the Paris zone; (3) that of 3000 fundamental stars; they will be published in a few years. The work on the Astrographic Chart is approaching completion; the 2500 copper plates, 26 × 26 mm., will be carefully stored, as it is suggested that they may form a priceless record of the state of the heavens in an age long after the paper copies have perished. It is hoped that the Paris Astrographic Catalogue will be completed in four or five years.

It is noted that M. Krassowski of Varsovie has undertaken the calculation of the perturbations of Giacobini's Comet 1896 V which is expected early next year.

Full details are given of the system of Time signals, which are under the direction of M. Bigourdan. M. Hamy has been investigating the diffraction of the images of stars and hopes to apply his results to obtain an improved diameter of the sun.

Photography of stars by the extreme red rays has been carried out experimentally, and it is proposed to continue this work on Mont Blanc. The aim is to study the possibilities of daylight star photography. The report also deals with spectroscopic work on bright stars, the sun and chromosphere, and several stars have been photographed in three colours with colour screens.

Research Items.

POTTERY-MAKING ON THE BLUE NILE.—In *Sudan Notes and Records*, April-July, 1922, Mr. H. A. Macmichael contributes a report, illustrated by sketches, of pottery-making on the Blue Nile. The vessels of which the manufacture is described are the *Burma* or pots for carrying and storing water, and the water-jars used for the *Sagias* or water-wheels. The implements used are a roughly smoothed lump of stone the size and shape of a penny bun, and an oblong, slightly concave, river shell, which, if unprocurable, can be replaced by a fragment of dry water-melon husk. With these the lump of clay is kneaded with donkey's dung, is beaten into shape, and smoothed. The industry of making the *Sagia* jars is not originally found in the Sudan, but is rather Nubian and riverain.

IMMIGRANT GROUPS IN AMERICA.—In the *Scientific Monthly* for November, Prof. Kimball Young discusses the results of applying intelligence tests to various immigrant groups in America. He points out that whereas up to the year 1882 the highest percentage of immigrants came from the British Isles and Northern and Western Europe, of recent years a complete change has taken place, the highest percentage now being from Southern and Eastern Europe. This change, he considers, is of the greatest importance for the future of America. If the more recent additions to America are of a less intelligent stock than the earlier inhabitants, then the consequences will be serious for the future. In order to test intelligence, the writer used the already well-known American Army tests, modified to suit the children he was testing, and he also considered the work of others studying racial differences by like methods. As a result of a very careful study he brings forward evidence to show that the intelligence of these Southern European stocks is very much lower than that of the other stocks. If that is so, then the continued dilution of the original, more intelligent, stocks by these inferior ones will seriously affect the average intelligence of the population of the country. As a practical deduction, it is urged that there must be a complete change in public opinion on the desirability of large numbers of immigrants; and secondly, that immigration must be controlled in the interests of the national welfare, new-comers not being allowed to enter unless they can read a certain standard in intelligence tests.

NEW ANTARCTIC BRITTLE-STARS.—The Ophiuroids collected by the Australasian Antarctic Expedition (1911–1914), under the leadership of Sir Douglas Mawson, are the subject of a memoir by Prof. R. Koehler, of Lyons, illustrated by 15 quarto plates, crowded (indeed over-crowded) with excellent photographs by the author (Sydney: John Spence. Price 10s. 8*d*.) There are 37 species, of which 19 are new, and three of the latter serve as types of three new genera—Ophiosparte and Ophiodaces among the Ophiacanthidæ, and Ophioceres, which is intermediate between Ophiolepis and Ophioplocus in the Ophiolepididæ. Ophioripa also appears to be a new generic name, unless, indeed, Prof. Koehler's report on the Ophiuroids collected off the Philippines by the *Albatross* was published before this one. Some nine species previously known from the Antarctic or sub-Antarctic have their horizontal and bathymetric limits considerably extended. *Asteronyx loveni* and *Homalophiura irrorata*, being now found in the Antarctic, may claim to be absolutely cosmopolitan species. The latter was dredged at a depth of 1800 fathoms along with a new Astrodia and *Ophiomusium planum*, which last was previously known from great depths in the Atlantic and Indian Oceans. When so much is added to our knowledge from only fourteen stations, we realise how much there must be still to learn. We may, however, hope that the number of recent ophiuroid genera will not be greatly increased.

"INSULIN" AND THE OXIDATION OF SUGAR.—The experiments of Von Mehring and Minkovski in 1889 showed that in the absence of the "Islets of Langerhans" of the pancreas, sugar was imperfectly utilised by dogs, thus leading to the condition known as diabetes mellitus. An internal secretion was naturally supposed to be responsible, but extracts of the pancreas were found to have little or no capacity of replacing the islet tissue. It seems that some constituent of the whole pancreas, perhaps trypsin, destroys the internal secretion. It occurred to Dr. Banting of London, Ontario, that if use were made of glands in which the ordinary secreting tissue had degenerated as a result of tying the duct, this destruction might not occur. Accordingly, arrangements were made by which Banting, in conjunction with a group of workers in Prof. Macleod's laboratory at Toronto, investigated the question. The results have been published in a series of papers in the *Trans. Roy. Soc. of Canada*, the *Amer. Journ. of Physiology*, and elsewhere, under the names of Banting, Best, Macleod, Collip, and others. Active extracts were obtained in the way mentioned, and finally a method was discovered by which they could be got from ordinary pancreas, by the use of alcohol, in a form suitable for hypodermic injection. The preparation has been named "insulin." It has the properties of increasing the consumption of sugar by the tissues and indirectly that of fat, which is incompletely burned in the absence of the oxidation of sugar. The concentration of sugar in the blood, both of normal and of diabetic animals, is thus reduced. That it is burned is shown by the rise of the ratio between the carbon dioxide expired and the oxygen taken in, as also by direct experiments on the excised heart. The toxic effects of the products of incomplete oxidation of fat disappear. An important new fact is that the blood sugar of normal animals can be reduced to a low level, and when this is reached various abnormal symptoms appear, especially in the nervous system. In the rabbit, attacks of convulsions finally lead to death. All these results can be abolished immediately by giving glucose. Insulin is also effective in diabetes in man, but repeated injections are necessary since the effect of one dose lasts only about twelve hours, and each individual dose must not be so large as to bring about the low level of blood sugar above mentioned.

VISIBILITY AS A SIGN OF COMING RAIN.—Exceptional visibility as a sign of coming rain is discussed in the *Meteorological Magazine* for October from observations made by Mr. W. H. Pick of the Meteorological Office, Air Ministry, at Cranwell, Lincoln. Observations were taken on 518 days from April 1, 1920, to August 31, 1921. Visibility is observed hourly, and the classification of a day with visibility of 21 miles or more is a day on which such visibility was observed at one or more of the hours from 9 h. to 17 h., and similarly with a visibility of 13 miles, the latter being naturally included in the visibility of 21 miles or more. The days with rain between the period of visibility and 7 h. on the following morning are also tabulated. An examination of the data is said to show that, so far as Cranwell is concerned,

there is no evidence that a day of exceptional visibility is more likely to be followed by rain than a day of low visibility; the author says, rather the reverse. Only one-third of the days with visibility 21 miles or more were followed by rain, while with visibility less than 13 miles one-half of the days were followed by rain. A discussion on visibility at a meeting of the Royal Meteorological Society last December has helped much to an understanding of the subject. Exceptional visibility or "nearness" is by no means a common feature, and for a test as a sign of coming rain, it seems to require different handling from that given by the author.

WEATHER IN KOREA.—The annual reports of the meteorological observatory of the Governor-General of Chosen for the years 1918 and 1919 have recently been received. They give hourly meteorological observations at Jinsen (Chimulpo) mostly from European self-recording instruments, and also daily means and extremes. At fourteen branch-stations the several meteorological means are given for each 4 hours for each month and for the year. For several auxiliary stations the mean highest, mean lowest, and mean temperatures are given, as well as the amount of precipitation and days with rainfall, also the maximum precipitation in a day at each station for each month, and the dates of first and last frost and first and last snowfall. There is great variation of temperature and rainfall at the different stations and at different seasons consequent on the varying heights of the stations and the vastly different exposures, the country being generally very mountainous. The auxiliary stations supplying data for the climatological investigation of the peninsula numbered 203 at the end of 1919. With the object of securing data for the investigation of thunderstorms four hundred head masters of the ordinary Korean schools report all the phenomena which accompany the storms, and this will be continued for three years from 1918, confining the reports to the warm season from April to September. The continuity of these observations, year after year, adds greatly to the general knowledge of the world's meteorology. Magnetic observations, which formed part of the ordinary routine, have for the time been suspended owing to the destruction of the quarters by a severe storm in September 1919.

THE ROCKY MOUNTAIN OIL-FIELD.—New information concerning oil possibilities of the great Rocky Mountain Field of North America is always of interest, and particularly so in connexion with Montana, which, compared with the adjacent State of Wyoming, has up to the present yielded surprisingly poor results. Stratigraphically and structurally there is much territory in Montana which should prove favourable, though large areas are at present unprospected for oil and gas. Mr. W. T. Thom, Jr., in a brief report published recently, has thrown much light on at least one interesting district, that of the Crow Indian Reservation, in Big Horn and Yellowstone counties, the southern part of the State. Some 3000 square miles of this Reservation, lying to the north and east of the Big Horn-Pryor Mountain uplift (forming the dominant regional structure), offer the best prospects, and within this area a local uplift known as the Soap Creek Dome is being developed; most of the oil obtained has been won from the Amsden formation, a shale-and-sand series of Pennsylvanian age. The underlying Madison Limestone—a particularly pure limestone of Mississippian age and well developed in central and southern Montana—has also yielded oil at Soap Creek. Although no mention is made of the quality of the oil obtained during developments, it may be stated that great variation in gravity is the general characteristic of the petroleum obtained in southern Montana and northern Wyoming; such variation is dependent largely on the different geological horizons from which the oil is drawn, and in many instances, owing to the complexity of structure and widespread faulting, the nature of the oil changes with almost surprising rapidity from well to well. The future of the whole Rocky Mountain Field as regards oil production centres largely in the States of Wyoming, Colorado, and Montana, and although up to the present Wyoming has produced more than 90 per cent. of the oil obtained, the prospects for the other two States are by no means discouraging, as the present Crow Reservation bulletin reveals.

GRAIN SIZE IN PHOTOGRAPHIC EMULSIONS.—The nature of the developable image, the cause of sensitiveness, the relation between the size of the particles in a photographic emulsion and its sensitiveness, and other allied problems, have received a great deal of attention at the hands of several investigators during the last few years. This work has led to various hypotheses, which have been noted from time to time in our columns, all of which have not been generally accepted. Messrs. E. P. Wightman, A. P. H. Trivelli, and S. E. Sheppard, of the Research Laboratory of the Eastman Kodak Company, publish the first of a series of papers entitled "Studies in Photographic Sensitivity" in the October number of the Journal of the Franklin Institute, in which they propose to examine these hypotheses, to note wherein they lead to similar conclusions, and so far as possible to test experimentally between them. The present paper is on the distribution of sensitivity and size of grain in photographic emulsions. The authors discuss the existence and nature of statistical variation of sensitivity among silver halide grains, and the relation of this variation to the density-exposure function. It is concluded that under certain conditions the first derivative of the density-exposure function will correspond with the intensity-variation function or curve. The results of experimental determinations of grain-size-frequency curves are noted, and correlated with sensitometric data. The decisive influence of the grain-size distribution and limits on the "speed" and other sensitometric variables is discussed in relation to the "quantum" and the "photocatalytic" theories of grain sensitiveness.

"ELECTRETS," THE ANALOGUES OF MAGNETS.—For the last three years Prof. Honda and his pupils at the University of Sendai have been investigating the conditions under which rods of solid dielectrics permanently charged with positive electricity at one end and with negative at the other could be produced. In the most recent work of Mr. M. Satô, described in the June issue of the Science Reports of the University, a tube containing a molten dielectric has electrodes at its ends connected respectively to the positive and negative terminals of an electrical machine. The dielectric is allowed to solidify slowly from each end, the middle portion remaining liquid longest, and when the rod of solid dielectric is extracted from the tube, it is found to be charged positively at one end and negatively at the other, and the charges will continue apparently for years. If the rod is cut into short lengths each length is permanently charged, the amount of the charge being proportional to the distance of the length from the middle of the rod. According to Mr. Satô, these "electrets" are due to the ions held in fixed positions by the solidification of the dielectric.

The International Geological Congress of 1922.

THE publication of the complete "Livret-Guide des Excursions en Belgique" and "Résumés des Communications Annoncées" affords us an opportunity of reviewing the work of the first International Geological Congress which has met since the war.

There are few countries that are so eminently adapted for a geological gathering as Belgium. With the exception of strata of pre-Cambrian age, all the formations are adequately represented within an easy railway journey from the capital. The rocks are well exposed on the sides of the deeply-cut river valleys and in the numerous quarries for limestone and sandstone, which are being actively worked for building material and road metal, and valuable information has been afforded by the coal mines and borings for coal. There has accordingly been every facility for the investigation of the geological structure, which is of the greatest interest. The area was subjected to great movements from the south in connexion with both the "Caledonian" and "Hercynian" epochs of disturbance in the earth's crust. The latter, which took place at the close of the Carboniferous Period, resulted not only in numerous well-marked folds but in extensive thrusts (*charriages*) from the south which brought older strata over those of younger age, in the same manner as ancient crystalline rocks were forced over Cambrian strata in the north-west highlands of Scotland during the Caledonian movements.

The very full and clear development of Devonian and Carboniferous strata and the careful work of the Belgian geologists upon them render a visit to Belgium peculiarly instructive to students of those formations in this country and throughout the world. The succession, too, of the Tertiary rocks of Belgium is also remarkably complete, and many of our British geologists welcomed the opportunity of familiarising themselves with them.

Nothing could exceed the efficiency with which the congress was organised, and this reflects the greatest credit on M. Armaud Renier, the General Secretary, and his co-workers.

In one respect the congress presented a remarkable contrast to scientific gatherings in this country. Every member was permitted in all his railway journeys in connexion with the congress to travel at half the usual rates, whereas the members of the British Association know to their cost that since the war the railway companies have refused to abate a penny of their fares to those who take part in the annual meetings.

Excursions were carried out before, during, and after the meeting at Brussels. Those before the congress lasted from six to nine days, and comprised traverses from south to north in the east of Belgium (M. Fourmarier) and in the centre (MM. Kaisin, Mailleux, and Asselbergh), and a special study of the metamorphic regions of Veilsalm and Bastogne (M. Lohest) and also of the Tertiary rocks (M. Leriche). The excursions after the congress included studies of the Cretaceous and Tertiary rocks of the neighbourhood of Mons (M. Cornet) and of the Carboniferous strata (MM. Lohest, Kaisin, and Renier), while M. Fourmarier devoted a fortnight to a detailed survey of the remarkable tectonics of the Palæozoic rocks. The "Livret-Guide" to these excursions remains as an invaluable work of reference on the geology of the country.

The formal opening of the congress took place on August 10 in the presence of His Majesty the King of the Belgians, and M. Jean Lebacqz was elected president. Two or three sessions were held simultaneously and numerous important papers were read. A large number of these dealt with the character of the Hercynian disturbances in different areas, and they constitute important contributions to the literature of the subject, but much still remains to be done in correlating these movements and determining how far they were contemporaneous or successive in adjoining regions.

A noteworthy feature of the congress was the presence for the first time of representatives from Poland, Czechoslovakia, and Yugoslavia. No invitation was extended to the Central powers, which were on this occasion unrepresented. A proposal, which originated with MM. De Margerie and Lacroix, to prepare an international geological map of Africa, was welcomed by the representatives of the other powers having interests in that continent, and they agreed to co-operate in the undertaking.

It was proposed by Señor Rubio-y-Muñoz, the principal representative of Spain, that the next congress should take place in Madrid, and an attractive programme of excursions was promised. This was unanimously accepted. The question was raised as to whether the congress should continue on the lines which had hitherto been followed or should be transformed into an International Union of Geology affiliated to the International Research Council. There was a strong feeling in favour of the former course, and a constitution was adopted which will, it is believed, ensure the preservation of the past traditions of the congress as a great reunion of fellow-workers in geology in which all nations are represented.

J. W. E.

Education, Research, and Invention.

IT is natural to find that a large portion of the presidential address delivered before the Institution of Mechanical Engineers by Prof. H. S. Hele-Shaw on October 20 should deal with education, research, and scientific knowledge and invention, in all of which the president himself has played an important part. The Institution has now before it the results of the first year's work in the examinations for national certificates and diplomas. These examinations are conducted by the technical schools, together with assessors appointed by the Institution, who are responsible for considering all papers and for reviewing and supervising all results. All the results are submitted to a joint committee of the council of the Institution and the Board of Education, and all border-line cases are specially considered. It is of interest to note that in more than one case the Institution has had to modify the severity of the school, which is far more satisfactory than if technical schools desired to pass their candidates too easily. Of the 1250 candidates drawn from forty-eight technical schools, fifty-one per cent. have been awarded various grades of national certificates and diplomas. The Institution does not appear as yet to be ready to give a decision as to whether these examinations will be accepted in lieu of the Institution's own examinations for associate membership, although the matter appears to be under consideration.

It is now nearly fifty years since the Institution appointed its first research committee; since then

the sum of between 13,000*l.* and 14,000*l.* has been expended in research. There is no doubt that this policy has greatly enhanced the reputation of the Institution and has been of the utmost value to the engineering world. The time has arrived when the relation of the Institution to the National Physical Laboratory and the Government Department of Scientific and Industrial Research must be carefully considered. In view of present-day demands on the Institution and its members in all parts of the world, the council must consider to what extent, if any, it will be able to contribute in future to researches which may well be left in the hands of the above-mentioned bodies. The Institution is closely associated with both bodies through several members of council, and these will continue, as in the past, to give freely their services and experience. There is also a feeling that the Institution should not encroach upon the ground which newer and special Institutions are better qualified to undertake.

Prof. Hele-Shaw has long been known for his interest in inventions, and his remarks on inventions and inventors are of value. All progress, at any rate in mechanical science, must be in the nature of invention. Every step taken in which new ground is trodden, every new device or new mechanism, or new machine of changed form, in which the movements of parts differ, or even if the object attained is different, can result only from the exercise of the inventive faculty. If a man cannot do more than alter the dimensions of the machinery which he is constructing, he cannot be called an engineer at all. Even where it is necessary to duplicate indefinitely any existing machine or machine part, invention is required, and has in recent years been exercised in a wonderful way for production purposes.

The present stress of competition necessitates the more intense application of the inventive faculty, and an average of 30,000 patents is taken out each year by inventors searching for new devices and new results. It is easy to see what a hopeless task is being attempted by the ignorant and uneducated inventor. In one case he is probably attempting to discover something well known; in the other he lacks the education which would prevent him from attempting the hopeless task of trying to produce the impossible. Any one who studies the *Patent Journal* week by week must see that even to-day the attempts of a large number of inventors would be ludicrous if they were not in most cases pathetic. The truth, however, must be told—engineers in practice in the course of their work constantly spend large sums of money on inventions which, if they are more plausible, are not less impossible than those above mentioned.

Prof. Hele-Shaw has long thought that, beyond general engineering training, the time has come for an actual chair of invention. He hopes to see such a chair founded somewhere, and that a professor of invention may give lectures (one or more a year) to engineering students of different schools throughout the country. This would enable the principles on which success depends to be placed before rising engineers, as well as the methods of obtaining information on what had been already achieved in any subject, the cause of failure in previous attempts, and how to approach new problems so as to avoid falling into endless repetitions of previous workers.

The Life History of the Eel.

THE complete story of the breeding of the European eel has now been told by Dr. Johs. Schmidt in a memoir published by the Royal Society (Phil. Trans. B, vol. 211, pp. 179-208, plates 17, 18, April 4, 1922). The publication will become a classic of science, not only because of its literary charm and the results that it sets forth, but as a record of the resolution of a man of science determined to carry his investigation to a satisfactory conclusion.

In May 1904 Dr. Schmidt, while working on fishery research on board the Danish Fishery vessel *Thor* west of the Faroes, found a Leptocephalus larva of 7½ cm. in length. "With little idea, at that time, of the extraordinary difficulties" of the investigation, he began his research. From then till 1910 he made what use he could of the *Thor*, but the vessel was too small. He obtained collections made by the *Michael Sars* and others stored in Danish museums, but the material was very inadequate. Then he persuaded various Danish shipping companies to help, and the skippers were supplied with nets and instructions. One ship-of-war also assisted. In 1913 a Copenhagen company allowed him the use of the *Margrethe*, and for five months all went well. Then the *Margrethe* was wrecked on a West Indian island, "but the collections fortunately were saved"! In 1914 and 1915 the United States Fishery vessel *Bache* and two Danish traders obtained plankton samples, and then the war stopped all further collecting till 1920. Finally, a Copenhagen company gave Dr. Schmidt the use of the *Dana*, and with the experience gained, abundant collections were made in 1920 and 1921. It was then, "with mingled feelings," that he found that the rich material included two species of eels, the American and European. These could only be separated by laborious countings of the myotomes and pigment spots, and all this had to be done aboard ship immediately after the fishing operation.

The outcome of all these difficulties is the almost complete story of the European eel. For a period of five to twenty years, according to sex, climate, and quantity of food, the eel remains in fresh water. It is yellow-green in colour and without metallic lustre. Then the desire for food fails; the migratory instinct awakens; the silvery "bridal dress" is assumed, and the eels descend to the sea. This is the last that is seen of them, and the period of their migration is unknown. Sometime during the spring or summer, however, they spawn, in deep water, in the West Atlantic between about 22° and 30° N. lat. and 50° and 65° W. long. (roughly in the middle of the Sargasso Sea). The smallest larvæ caught are about 7 to 15 mm. in length, and they are found at about 200 to 300 metres from the surface. From then onwards their area of distribution widens. They rise to near the surface of the sea and begin to migrate to the north-east. In the first summer they are about 25 mm. long, and are found west of 50° W. long. In the second summer they are 50 to 55 mm. long, and they then inhabit the central Atlantic. In the third summer they are about 75 mm. long, and can now be found on the European coastal banks. They are still leaf-shaped, transparent Leptocephali, but in the autumn they undergo metamorphosis and enter the rivers as the cylindrical, smoky-brown elvers, about three years in age. The further history is well known: they may ascend rivers to a height of 3000 feet above sea-level (in Switzerland). Growth proceeds, and some five to twenty years later the seaward migration occurs. The story is unique in natural history, not only for its own interest, but also because of the patience and resolution with which it has been elucidated. J. J.

The Harrison Memorial.

UNVEILING AT THE CHEMICAL SOCIETY.

WHEN, casting aside the shreds of national honour, the Germans initiated the use of chemical poisons on April 22, 1915, they added yet another phase to the invisible struggle which accompanies every modern war. In this phase of the late war, involving the chemical laboratories and industries of the combatant nations, the late Lieut.-Col. E. F. Harrison was destined to play a notable part.

Leaving a busy chemical consulting and analytical practice, he succeeded, in May 1915, despite his age, in enlisting in an infantry battalion. On account of his chemical knowledge, he was soon transferred to the Royal Engineers, and took part in the early work of the Anti-Gas Department, created to provide troops in the field with protection against the new chemical weapon. He quickly received a lieutenant's commission and thereafter rose in rank as his duties increased in importance and responsibility; by the end of 1917 he was head of the Anti-Gas Department and in charge not only of the manufacture of respirators, but also of the incessant research necessary to perfect the respirator and render it impervious to any new chemical substance the enemy might be expected to use. At this time the Anti-Gas Department was united with the Chemical Warfare Department, under the Ministry of Munitions, and Harrison was appointed Deputy Controller of the combined organisation. Shortly before his death on November 4, 1918, he became Controller of the Department.

It has been said that Harrison was one of the discoveries of the war; the discovery was a providential one for this and other countries. It revealed a man of intense, incessant energy and determination, of exceptional organising power; it brought forward a chemist of foresight prepared to face the gravest responsibilities. To this man was largely due the fact that our troops, once the initial surprise was past, were furnished with adequate and timely supplies of the most efficient respirator employed by any nation during the Great War. No more fitting verbal tribute could be paid than that of F. H. Carr in his Harrison Memorial Lecture (*Pharmaceutical Journal*, 1919, p. 93), to which the reader is referred for a detailed account of Harrison's life and work.

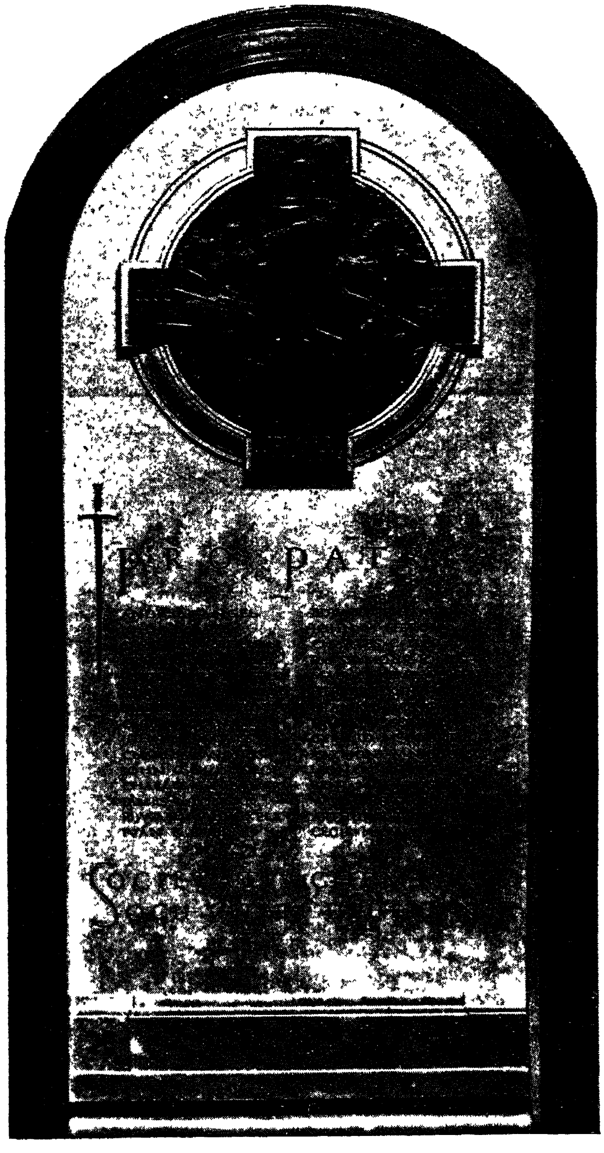

FIG. 1.—The Harrison Memorial, Chemical Society, Burlington House.

Energy and devotion were the cause of his death. Attacked by influenza and weakened by his exertions, he refused to leave his work. Those who attempted to dissuade him—the present writer was one — were told that he was going to see his job through; by a week he failed to do so. But his death did not occur until the country was assured of victory and he himself had realised the final success of his labours. He gave his life to his country as truly as did those who died on the field of battle.

To Harrison and other fellows of the Chemical Society who gave their lives during the war, a memorial in the rooms of the society was unveiled by the Earl of Crawford and Balcarres on Thursday, November 16. As chairman of the Harrison Memorial Fund, Sir George Beilby stated that a sum amounting, with accrued interest, to some 1640*l*. had been collected from Col. Harrison's colleagues and friends. A portion of this sum had been utilised in erecting the upper part of the memorial; the Chemical Society co-operated in adding the lower portion, on which are inscribed the names of those Fellows who gave their lives during the war. The remainder of the fund had been conveyed in trust to the Chemical Society; the interest upon the fund will be used in providing, every three years, a prize of approximately 150*l*. to the chemist—man or woman—not more than thirty years of age, who, during the previous five years, shall have carried out the most meritorious original investigations in chemistry. The prize will be awarded upon the recommendation of a committee composed of the presidents, for the time being, of the Chemical Society, Institute of Chemistry, Society of Chemical Industry, and the Pharmaceutical Society; it will be given, provided that a sufficiently

distinguished candidate is available, for research in any branch of chemistry, pure or applied, and no restrictions will be placed upon the manner in which the prize is utilised by the recipient. The donors of the fund, explained Sir George Beilby, hope that the prize will do something to stimulate young research chemists to greater effort, form a not unworthy tribute to the memory of Col. Harrison, and serve to remind the chemists of the future how their science was employed in the cause of right and humanity.

Sir James Walker, president of the Chemical Society, in a brief speech accepted the fund and trust deeds, and the custody of the permanent memorial. Before unveiling the latter, Earl Crawford referred with sympathetic insight to the work of Col. Harrison during the war, and to the loss suffered by the country in the death of Harrison and the remaining Fellows of the Society whose names are inscribed upon the memorial. He expressed the hope and belief that the prize fund would fulfil the desire of the donors to encourage the younger chemists in research, a purpose which Harrison had ever in his thoughts. The unveiling of the memorial was marked by the sounding of the "Last Post"; after a minute's silence the "Reveille" concluded a simple and dignified ceremony.

The permanent memorial (Fig. 1) is the work of Mr. Ernest Gillick; it is of singular beauty. The bronze medallion bears an appropriate representation of a trench scene at the moment of a gas alarm. It is set upon marble, the natural colour of which harmonises with the bronze. In the rooms of the Chemical Society the memorial finds a most fitting home, and it is satisfactory to know that, should the Society change its quarters, it will be possible to transfer the memorial to the new rooms. C. R. Y.

Long Distance Telephony.

MR. F. GILL, the "European Engineer-in-Chief" of the Western Electric Co., chose the subject of telephony over long distances, with special reference to the international problems of communication between the various countries of Europe, in his presidential address to the Institution of Electrical Engineers delivered on November 2. Incidentally he pointed out that the passive attitude of a Government, content to satisfy the public demand only, would never lead to an efficient service. The success of the "Bell-owned" companies in the United States is due to an intensive educational campaign coupled with construction well in advance of the demand. In the United States the number of telephone stations has been increased ninefold during the last twenty years, and there is now one telephone station to every 7·7 persons. In Mr. Gill's opinion a Government Department should earn something more than merely sufficient to pay its way. If this were done there would be no difficulty in getting the capital necessary to extend the business. With a large staff it is disastrous that the idea should prevail that profit-earning is of no account.

Mr. Gill stated that the "carrier" system has greatly increased the maximum load possible on given lines. In this system carrier waves of frequency between 4000 and 27,000 per second are used, and by means of "wave filters" they can be separated into different circuits without difficulty. On the New York–San Francisco line there are four conductors which form simultaneously two physical, one phantom, and four earthed telephone circuits. They also form part of a varying number of telegraph circuits ranging from six to twenty. The introduction of the thermionic repeater in 1914 gave a great impetus to telephonic development. As many as 23 of these repeaters have been used in tandem without seriously distorting speech. Mr. Gill gave data to prove that the telephone system of the United States is in advance of European systems.

In conclusion Mr. Gill discussed the problem of improving the through telephonic system of Europe. In Europe there is no organisation to co-ordinate the forty local systems. If a line were constructed between London and Christiania it would probably traverse six intermediate countries. The direct distance between London and Bagdad is about the same as that between New York and San Francisco, between which daily conversations take place. Under present conditions through telephony in Europe can be of little value. Mr. Gill then suggested alternative schemes for international control and urged that every endeavour should be made to secure it. The telephone authorities of Europe should hold a conference to try to find a solution, for to be interested jointly in a flourishing telephone undertaking would increase goodwill among nations.

Low Temperature Carbonisation.[1]

By Prof. JOHN W. COBB.

THE report of the Fuel Research Board for the years 1920-21 on "Low Temperature Carbonisation" has been awaited with interest in many quarters because the subject has been much debated, and it was known that experiments were being carried out by Sir George Beilby and his staff at the Greenwich experimental station. On one hand, the process has been spoken of in terms of unrestricted enthusiasm and optimism as providing a simple and general solution of the smoke problem through the smokeless solid fuel which was to be produced, and as yielding large supplies of liquid fuel for naval and other purposes through its promised high yields of tar. On the other hand, critics of the process have indicated some shortcomings. The gas yield is small, and the process of carbonisation as carried on at higher temperatures in the gasworks is paid for mainly by the large volume of gas which can carry a much higher price per thermal unit than a solid fuel because each thermal unit is worth so much more in use. Again, one of the principal by-products of carbonisation—ammonia—can be obtained only in comparatively small quantity by low temperature carbonisation, and the tars are much less valuable by current standards than those produced at higher temperatures because they lack aromatic constituents and are deficient in some other respects.

Sir George Beilby, who signs this report, has approached the investigation in an entirely sympathetic spirit. As a matter of fact, he was busy with the subject before it excited the amount of interest which is now bestowed upon it, and in this report he has detailed not only the results of experiments carried out by the Fuel Research Board, but reviewed the work of other investigators.

In a preliminary review of the situation, Sir George Beilby points out that broadly speaking this country

[1] Department of Scientific and Industrial Research. Report of the Fuel Research Board for the Years 1920, 1921. Second Section: Low Temperature Carbonisation. Pp. iv+73+8 plates. (London: H.M. Stationery Office, 1922.) 2s. net.

has to depend on overseas sources for its supply of fuel oil of all kinds, but that the market for fuel oils is not trustworthy commercially, the price having fallen from more than 15*l*. per ton to from 3*l*.–4*l*. during the past eighteen months. "The bearing of this fall in price upon schemes for the low temperature carbonisation of coal will be at once appreciated when it is stated that it represented a drop of at least 10s. on the value of the fuel oil obtainable by carbonisation from 1 ton of coal." At the same time, it must be remembered that in low temperature carbonisation, fuel oils and gas only amount to about 6 to 9 per cent. respectively of the products, 70 per cent. being coke, and the opinion is expressed that the profitable working of the low temperature process must depend largely upon a recognition of the superiority of low temperature coke to raw coal as a fuel, which takes the practical form of willingness to pay a higher price for it. If that were secured so that the process could be adopted by gasworks, it is suggested that the rich gas produced in the process could be brought into use as an enriching agent for the raising of low grade gas made in other ways to a higher standard of calorific value. Plainly, however, any wide adoption of the process would depend upon the difference in price between the solid smokeless fuel and raw coal being small, and the position is summarised thus: "This process as an industrial operation will stand or fall on a perfectly definite issue which is whether or not it is possible to evolve an apparatus on sound engineering lines in which the capital and working costs would fall within the modest margin of working profit on which the industry must be founded."

The working out of any such process in its best form depends upon a thorough knowledge of the changes which coal, or rather coals, of different kinds undergo in the process of carbonisation, and the report deals with work on this subject. It includes interesting results which have been obtained in a study of the microstructure of cokes produced from different coals in different ways, and emphasises the value which attaches to the proper blending of coals for the carbonisation process as influencing their behaviour in the carbonisation process, and the quality of coke which can be produced from them. The work has, however, gone beyond the laboratory stage, and experimental apparatus has been devised and worked in which the peculiarities of the low temperature process for good or evil have been brought out. The following results can be taken as typical of those obtained by low temperature carbonisation in horizontal retorts:

YIELDS AT 600° C. PER TON OF COAL (DRY)

Coke	14·5 to 15·5 cwts.
Crude oil	13·0 to 17·0 gallons.
Liquor	7·0 to 15·0 gallons.
Ammonium sulphate	4·5 to 8·5 lbs.
Gas	3000 to 3500 cub. ft. = 27 to 35 therms.

The coke is a smokeless solid fuel, the smoke-yielding constituents having been expelled. The gas is in small quantity but rich. The ammonia yield is very small, about one-quarter of what is usual in gasworks practice. The crude oil is some 50 per cent., greater in volume than would occur in ordinary gasworks practice. Its flash point was atmospheric, and when the light spirit was removed from it so as to give a fairly satisfactory flash point the oil was sufficiently fluid to meet the Admiralty specification at 15° C., but at 0° C. was much too viscous. The crude oil had a limited miscibility in mineral fuel oils—a grave practical shortcoming. The behaviour of the metal retorts used in this carbonisation was satisfactory in the sense that they showed no sign of distortion or depreciation after using for nearly two years, but the behaviour of steel in the moving parts of an automatic carbonising machine which was tried was not equally satisfactory, defects being encountered due to the loss of rigidity which occurs in steel at a temperature of 600° C. A number of points requiring further investigation have arisen, and the work now in hand includes the development of automatic methods of carbonisation, the study of briquetting as a preliminary to carbonisation, and the development of a practical method of briquetting at or near the fusing point of the coal. It is along some such lines that it is hoped to arrive at some form of process and appliance for low temperature carbonisation which will meet the technical and commercial demands which have to be satisfied if this method of dealing with coal is to find wide application.

Expedition to Chinese Tibet.

AS already announced, the Percy Sladen Trust Expedition to the Alps of Chinese Tibet, consisting of Prof. J. W. Gregory and his son, Mr. C. J. Gregory, has returned after a successful journey. The primary object of the expedition was the investigation of the geological structure of the mountain regions of China in localities which would throw light on the relations of the mountains of south-western China to those of the Himalaya and south-eastern Asia. The expedition left Bhamo on the Irrawadi in North Burma on May 7, and crossed the frontier hills to the "Treaty Port" of Tengyueh, where the Indian servants were sent back and a Chinese staff and muleteers engaged. Permission was there given by the Chinese magistrate to go to Likiang-fu, the administrative headquarters on the borders of Chinese Tibet. The expedition was allowed to proceed to Likiang-fu by a route across one of the blank areas on the existing map of Yunnan.

At Likiang-fu it was found that orders had been received from the capital of the province that the expedition was not to be allowed to go farther north; but the magistrate ultimately agreed to its going on if he were relieved of personal responsibility by a letter stating that the expedition was proceeding at its own risk, and in spite of his warning. From Likiang-fu it travelled through the valleys of the Yangtze-kiang and the Mekong. Work in the upper Salween valley was found to be impossible, as it was reached in a district smitten with famine owing to the excessive rains of the previous autumn. The return journey to the caravan, which had been left to proceed north along the eastern side of the Mekong, was by forced marches on short rations. At Atuntze excursions were made to the higher mountains between the Mekong and the Yangtze-kiang and to the glaciers of Pei-ma-shan. The return route was through Likiang-fu to the city of Tali-fu and thence by the main trade route across Yunnan to the starting-point at Bhamo.

The geological collections will, it is hoped, be worked out during the winter, and the results of the expedition can now be judged only by the field evidence. It indicates that while the structure of the foundation of the country is due to the Hercynian movements of upper Palæozoic date, the area has been affected by a series of uplifts which, both by direction and date, belong to a continuation of the Himalayan system into south-western China. Various botanical and zoological collections were made, most of which are being examined at the Natural History Museum, London, and the Indian Museum, Calcutta.

University and Educational Intelligence.

BIRMINGHAM.—The lectures on town-planning which form an interesting part of the activities of the department of civil engineering are on an unusually extended scale this session. These lectures owe their existence to the generosity of the late Mr. George Cadbury and the trustees of the Bournville Village Trust, and are intended not merely for the university students but also for municipal officers, professional men, and members of the general public. The first series, by Mr. William Haywood, is open to all without fee; it deals with the historical aspect of the subject, reviewing in turn ancient, medieval, renaissance, and modern town plans, and concludes with a consideration of the possibilities of Birmingham. In the second series of lectures, three are to be given by Mr. H. H. Humphries, City Engineer of Birmingham, two by Dr. John Robertson, Medical Officer of Health, who will deal with the health aspects of town-planning and the importance of environment, and five by Mr. F. C. Minshull, Chief Assistant Solicitor to the City of Birmingham, on the legal aspects of the subject, the operation and administration of schemes. The third series, of twenty lectures by Mr. Haywood, is more particularly intended for students of civil engineering. Class work in surveying and in working out problems in site-planning is given each week during the winter and spring terms.

CAMBRIDGE.—It is proposed to create a readership in biochemistry, the income of which is to be provided partly by the income from a capital sum of 10,000*l.* provided by Sir William Dunn's trustees.

The Henry Sidgwick Memorial Lecture at Newnham College will be delivered by Lord Rayleigh on December 2, the subject being "The Iridescent Colours of Natural Objects."

EDINBURGH.—Mr. C. G. Darwin, who was elected a Fellow of the Royal Society a few months ago, has been appointed as the first occupant of the newly instituted Tait chair of natural philosophy. Prof. Darwin is a son of the late Sir George Darwin, and since 1919 has been lecturer in mathematics at Christ's College, Cambridge, of which he is a Fellow. He is at present engaged in research at the Norman Bridge Physics Laboratory of the Californian Institute of Technology at Pasadena.

LEEDS.—The Treasury has sanctioned a grant to be made by the Ministry of Agriculture and Fisheries in aid of the new agricultural building. The Turner Tanning Machinery Company is to instal about 1100*l.* worth of new machinery in the Leather Industries Department.

Mr. A. H. Priestley has been appointed lecturer in bacteriology, and Mr. G. Priestley has been appointed assistant lecturer in cloth analysis.

LONDON.—The Senate has awarded to Mr. F. J. F. Barrington the William Julius Mickle Fellowship of 200*l.* in respect of the work which he has carried out during the past five years on the nervous mechanism of micturition.

The following doctorates have been conferred by the Senate—*D.Sc. in chemistry*: Mr. S. R. Illingworth, an internal student, of the Imperial College, Royal College of Science, for a thesis entitled "Researches on the Constitution of Coal"; *D.Sc. in economics*: Mr. R. M. Dawson, an internal student, of the London School of Economics, for a thesis entitled "The Principle of Official Independence"; *D.Sc. in physics*: Mr. E. V. Appleton, an external student, for a thesis entitled "Studies of the Triode Vacuum Tube"; *D.Sc. in veterinary science*: Mr. W. H. Andrews, an external student, for a thesis entitled "The so-called 'Staggers' or 'Pushing Disease' of Cattle in Natal," and other papers.

Applications are invited for the Graham scholarship in pathology in connexion with University College Hospital. The scholarship is of the annual value of 300*l.* and tenable for two years. The latest day for receiving applications (which should be sent to the Principal Officer of the University of London, South Kensington, S.W.7) is January 1. They must be accompanied by the names of not more than three references, one at least of which should be the name of some professor, lecturer, or teacher of the university or college in which the candidate has conducted his studies in pathology, and state the research upon which the applicant proposes to work.

OXFORD.—Sir William Dunn's trustees have offered to provide the sum of 100,000*l.* for the establishment of a School of Pathology, subject to certain conditions as to site, upkeep of chair and teaching staff, provision of a maintenance fund, etc. They have also offered the additional sum of 3000*l.* for the adaptation of the existing Department of Pathology as the future School of Pharmacology. At a meeting of Congregation on November 21 these offers were accepted.

THE *Times* correspondent at Toronto states that a fire occurred in the upper floors of the University of Montreal on November 14, doing damage estimated at between 50,000*l.* and 60,000*l.*

IT is stated in the *Chemiker Zeitung* that Dr. Fritz Straus, of Berlin, has been appointed professor of chemistry at the Breslau Technische Hochschule, and that Prof. Bodenstein has been invited to succeed Prof. Nernst in the Physical-Chemical Institute of the University of Berlin.

AMONG recent appointments are the following:—Mr. D. H. Peacock and Mr. F. J. Meggett to be professor of chemistry and professor of biological science respectively at Rangoon University, and Dr. R. A. Dart to be professor of anatomy in the University of Witwatersrand, Johannesburg.

THE annual prize distribution to the successful students of the Northampton Polytechnic Institute, Clerkenwell, E.C.1, during the session 1921–1922 will be held at the Institute on Friday, December 1. Dr. S. Z. de Ferranti, past president of the Institution of Electrical Engineers, will distribute the prizes and certificates.

THE following will represent the universities in the recently-elected House of Commons, the names of new members being in italics:—OXFORD.—Lord Hugh Cecil (U.) and Sir Charles Oman (U.); CAMBRIDGE.—J. F. P. Rawlinson (U.) and *J. R. M. Butler* (Ind.); LONDON.—*Sir Sidney Russell-Wells* (U.); COMBINED ENGLISH (Manchester, Liverpool, Durham, Leeds, Sheffield, Birmingham, and Bristol).—Sir Martin Conway (U.) and H. A. L. Fisher (N.L.); WALES.—*T. A. Lewis* (N.L.); SCOTLAND (St. Andrews, Glasgow, Aberdeen, and Edinburgh).—Sir Henry Craik (U.), *Sir George Berry* (U.), and D. M'Coig Cowan (N.L.); QUEEN'S, Belfast.—Sir William Whitla.

Calendar of Industrial Pioneers.

November 26, 1836. John Loudon McAdam died.—The great improver of road-making, McAdam began his experiments in Ayrshire, continued them at Falmouth, where he was a contractor for the Navy, and in 1815 was made surveyor general of the Bristol roads, where he introduced the method of forming a bed of stones broken into angular pieces. His process was gradually adopted with great advantage to commerce in all parts of the world.

November 27, 1811. Andrew Meikle died.—A millwright of Houston Mill, Dunbar, Meikle was the inventor of the modern type of threshing-machine. His machine is said to have saved this country 2,000,000*l*. per annum. In 1784 he conceived the idea of drums armed with beaters, and the first machine was made in 1786. He continued to improve it, but reaped little pecuniary benefit from his invention. In 1809 a subscription for him realised 1500*l*.

November 28, 1894. Sir Henry Hussey Vivian, first Baron Swansea, died.—The son of a merchant connected with the copper-smelting industry, Vivian, after leaving the University of Cambridge, directed works at Swansea, patented improvements in metallurgy, and introduced the manufacture of spelter and the production of nickel and cobalt. Through his efforts Swansea became "the metallurgical centre of the world." Vivian was remarkable for his energy and ability; he took part in local and national affairs, and after sitting in Parliament for many years was, in 1893, raised to the peerage.

November 29, 1766. John Wyatt died.—With Lewis Paul, Wyatt is credited with the important invention of spinning by machinery. Originally a carpenter in his native village near Lichfield, he afterwards entered the employ of Matthew Boulton. The compound weighing-machine now in general use and the roller bearing were invented by him.

November 30, 1866. John Mercer died.—Born in Lancashire in 1791, Mercer began work at nine as a bobbin-winder and became a hand-loom weaver. He studied mathematics and chemistry, became known for his experiments in dyeing, and, from 1825 to 1848, was partner with Fort Brothers. He contributed to the chemistry of dyeing, propounded a rational theory of catalytic action, and in 1850, after a long series of experiments, discovered the process of "mercerising."

November 30, 1906. Sir Edward James Reed died.—One of the foremost naval architects of his time, Reed was trained as a shipwright in the Royal Dockyards. In 1860 he became the first secretary of the Institution of Naval Architects, and in 1863, at the age of thirty-three, was made chief constructor of the Navy, a post he held till 1870. He introduced the belt and battery system and designed H.M.S. *Devastation*, the first mastless sea-going turret iron-clad. He afterwards designed many notable vessels for foreign navies, and as a public man was a strenuous advocate of scientific and technical education.

December 1, 1850. Aaron Manby died.—The builder of the first iron steam vessel to make a sea voyage, Manby founded the Horseley Iron Works at Tipton, Staffordshire, where, in 1821, he built the *Aaron Manby* of iron. This vessel was sent to London in pieces, put together in the Surrey Canal Dock, and in June 1822 crossed the Channel, taking a cargo of iron castings to Paris. Manby in 1819 established important engineering works at Charenton, supplied some of the earliest engines for the French Navy, and took a prominent part in the lighting of Paris by gas.

E. C. S.

Societies and Academies.

London.

Royal Society, November 16.—Sir Charles Sherrington, president, in the chair.—A. S. **Eddington**: The propagation of gravitational waves. The potentials given in Einstein's theory represent not only the absolute gravitational disturbance of the field, but also the metric of the co-ordinate system which is to a great extent arbitrary; consequently the speed of propagation of the potentials is not necessarily the speed of the absolute disturbance. Einstein showed that, when the co-ordinate frame is chosen subject to a certain restriction, the potentials are propagated with the speed of light. Considering the propagation of plane waves on unrestricted co-ordinates, it is found that "transverse-transverse" waves continue to have the speed of light, whereas the other two types of waves have no fixed speed when Einstein's restriction is removed. The latter types do not correspond to any absolute disturbance of the field. Of the three conceivable types of transverse-transverse waves, one is inconsistent with the equations of entirely empty space, $G_{\mu\nu}=0$; but this type nevertheless commonly occurs in Nature, namely, as a propagation of gravitational disturbance by light-waves. Divergent waves are also considered. Although the equations correspond to those of sound-propagation, no uniform spherical waves of gravitation can occur; they must always be complicated by doublet-sources for some of the components. The waves emanating from a spinning rod are worked out in detail, and it is found that (in agreement with Einstein) the rod must slowly lose energy by these waves; for a typical example the period of decay of the rotation is found to be of the order 10^{35} years.—J. H. **Jeans**: The theory of the scattering of α- and β-rays. A theory of scattering is developed in which both the feeble encounters of the theory of multiple scattering and also the violent encounters of the theory of single scattering are taken into account. The presence of single scattering produces very nearly the same effect as can be produced by a suitable adjustment of the constants in the law of multiple scattering, and this renders the separate experimental study of single scattering very difficult.—A. P. **Chattock** and L. F. **Bates**: On the Richardson gyro-magnetic effect. Richardson has shown that the angular momentum arising in a ferro-magnetic substance from unit change in its magnetic moment should have the value of $1 \cdot 13 \times 10^{-7}$ if gyrating electrons are responsible for its magnetism. Measurements of this quantity by the ballistic method for three specimens of iron and one of nickel are given. The results, divided by $1 \cdot 13 \times 10^{-7}$, agree to within $1\frac{1}{2}$ per cent. with one another, and their mean is 0·6 per cent. greater than 0·500. Close proportionality also exists between the change of magnetic moment and the angular momentum resulting. The specimen used consisted of an upright wire suspended by a quartz fibre. By the introduction of a hinged joint between wire and fibre the adjustment of the magnetic axis of the wire to the vertical is much facilitated, and measurements were made on reversal of magnetism instead of on merely reducing it to zero. The more perfect symmetry resulting from this procedure may be the cause of the more consistent results obtained. The effect on the results of the eddy currents in the specimen was not more than a small fraction of 1 per cent. for the specimens used. At high dampings the ordinary damping correction gives values that are too large.—P. M. S. **Blackett**: On the analysis of α-ray photographs. A large

number of photographs were taken of the ends of the tracks of α-rays from polonium in both air and argon, using C. T. R. Wilson's expansion method. There are sudden bends made by the tracks due to collision with the atomic nuclei, and the actual form of these bends is obtained from measurements of the double images given by the special camera designed for the work by Shimizu. The frequency of occurrence of bends of given type are consistent with the existence of an inverse-square law of force between the α-particles and the nuclei, when their distance apart lies between 6×10^{-12} and 10^{-9} cm. for argon, and 3×10^{-12} and 5×10^{-10} cm. for air. The velocity of the α-particles along the latter part of their tracks was also calculated from the frequency of the bends and found to be much lower than had been expected. Velocities so low as 10 cm. per second were obtained, and the relation connecting the velocity v and the range r was found to be roughly of the form $v \propto 2\frac{2}{3}$, instead of the form $v \propto 2\frac{1}{3}$ found by Marsden and Taylor for the early part of tracks by other methods. No anomalous effects were discovered as regards frequency or type of collision.—**J. H. Jones**: The kinetic energy of electrons emitted from a hot tungsten filament. When allowance is made for experimental and secondary effects the distribution of energy agrees with that given by Maxwell's law. Of experimental errors the most serious are probably due to difficulties of measuring the small currents involved and the temperatures. These lead to uncertainties which in individual experiments may amount to so much as 10 per cent. The secondary effects probably arise from contamination of the heated surfaces. This tends to increase the apparent energy of electrons emitted and the increase may amount to so much as 20 per cent. The abnormal electron energies found by Ting, which were as much as 100 per cent. in excess of the Maxwell distribution value, do not appear under satisfactory experimental conditions.—**W. Wilson**: The quantum theory and electromagnetic phenomena. From the point of view of the quantum theory such systems as atoms possess stationary states which are subject to conditions expressed by the equations—

$$\int p_s dq^{(s)} = n_s h.$$

The paper is chiefly concerned with an extended form of these quantum restrictions in which the momenta, p_s, are replaced by more general momenta, π_s, involving the components of the vector potential of the external field to which the system is subjected. —**S. Marsh** and **A. E. Evans**: On measurements of electrode potential drop with direct current and alternating current electrolysis. Electrodes of polished platinum, platinum-black, gold and nickel were used, normal sulphuric acid serving as the electrolyte. With direct current, anodic and cathodic effects were examined; with alternating current, the frequencies ranged from 25 to 80. Experiments were also made with various current densities. With all the metals examined, the cathodic drop increases with time, the curves (especially with polished platinum) resembling saturation curves in radioactivity. The anodic drop decreases at first and then rises similarly to the cathodic curve. With alternating current the electrode drop decreases during an interval depending on the frequency and thereafter increases slightly. The cathodic curves probably represent the effect of occlusion, while the anode curves represent the opposing effects of oxidation and occlusion.

Royal Microscopical Society, October 18.—Prof. F. J. Cheshire, president, in the chair.—**R. Chambers**: New apparatus and methods for the dissection and injection of living cells. With the new apparatus there is a complete absence of lost motion, and continuous and accurate control of the needle in every direction under an immersion lens. The needle is maintained in one plane while it is being moved. Adjusting devices facilitate placing the needle or micro-pipette in position. The instrument consists essentially of rigid bars which are screwed apart against springs, the movements of the needle tip being in small arcs of a circle with a radius of about $2\frac{1}{2}$ in. There are three horizontal bars which are forced apart by two screws. When the screws are reversed, spring hinges at either end holding the bars together in pairs return them to their original position. A similar pair of vertical bars attached to the horizontal ones controls up and down movements of the needle. With this instrument the most delicate operations in micro-dissection, such as puncturing blood corpuscles or even cutting up chromosomes, can be performed. A new micro-injection apparatus is also described, as well as methods for making the needles and the moist-chamber.

Zoological Society, October 24.—Dr. A. Smith Woodward, vice-president, in the chair.—**J. P. Hill** and **R. H. Burne**: The fœtal membranes and placentation of *Chiromys madagascariensis*.—**R. I. Pocock**: The external characters of the fœtus of *Chiromys madagascariensis*.—**R. Kirkpatrick** and **J. Metzelaar**: On an instance of commensalism between a hermit-crab and a polyzoon.

Society of Public Analysts, November 1.—Mr. P. A. Ellis Richards, president, in the chair.—**C. Ainsworth Mitchell**: The colorimetric estimation of pyrogallol, gallotannin, and gallic acid. A ferrous tartrate reagent is used. The violet coloration produced is due to the pyrogallic group and, applied quantitatively, affords a measure of that group in different compounds. The reaction throws light on the constitution of gallotannin; the results for tannin from China galls are more in accordance with the formula recently suggested by Nierenstein than with that previously accepted. To estimate gallotannin in the presence of gallic acid the substances are estimated together colorimetrically in terms of gallic acid or pyrogallol. The tannin is then precipitated with quinine hydrochloride and the gallic acid estimated in the filtrate. The difference between the two results, multiplied by a factor, gives the gallotannin. The method has been applied to the estimation of tannin and gallic acid in various natural and commercial products.—**H. E. Annett** and **M. N. Bose**: The estimation of narcotine and papaverine in opium. Small quantities of opium (1-2 grams) only were available from plants used in selection experiments on the poppy. In estimating narcotine and papaverine an old observation of Plugge's, that on addition of sodium acetate to an aqueous opium extract, narcotine, papaverine, and narceine are precipitated, was used. Given the right conditions, the first two are precipitated completely; the narceine carried down can be washed away with water, and in the washed precipitate after further purification narcotine can be estimated polarimetrically.—**H. E. Annett** and **R. R. Sanghi**: The estimation of codeine. Codeine is extracted by toluene from an aqueous alkaline extract of opium, converted into the hydrochloride, purified by re-extraction with toluene, and finally converted into hydrochloride and weighed as such. The process is an improvement of that previously described by Annett and Son.—**J. R. Nicholls**: The estimation of morphine. If a 50 per cent. alcoholic solution containing morphine liberated by means of ammonia is shaken with half its volume of chloroform,

about 85 per cent. of the total morphine is in the lower layer; 2 such extractions remove more than 99 per cent. The alcohol retards or prevents the crystallisation of the base from the upper layer, and ensures a rapid separation.—R. L. **Morris**: Further notes on the estimation of potassium: by perchlorate and cobaltinitrite methods. A modification for the direct estimation of potash in the presence of phosphates of calcium, magnesium, iron, etc., is described. Sulphates should be removed by precipitation with barium chloride. Drushel's modification of the cobaltinitrite-permanganate process gives trustworthy results. Half-saturated sodium chloride solution should be used for the final washing of the precipitate.

EDINBURGH.

Royal Society, November 6.—Prof. F. O. Bower, president, in the chair.—J. H. **Ashworth**: On *Rhinosporidium seeberi*, with special reference to its sporulation and affinities. *Rhinosporidium seeberi* is parasitic in the connective tissue of the nasal septum of man, and causes proliferation resulting in the production of polypoid growths, a case of which has been under observation for four and a half years. The trophic stages of Rhinosporidium may be intracellular, but the great majority lie between the connective tissue cells. As growth proceeds, granules of protein and fat-globules appear in the cytoplasm and increase in number and in size. When the organism approaches 0·1 mm. in diameter the nucleus divides by mitosis. There are four chromosomes. Other nuclear divisions follow; the nuclei (with few exceptions) divide synchronously. About the time 128 nuclei are present the cell-wall, hitherto chitinoid, becomes much thickened, except at one point, by deposition of cellulose on its inner surface. The nuclear divisions continue, and, after the twelfth, cleavage of the cytoplasm takes place and rounded cells are formed, which undergo two further divisions to form the spores (about 16,000). Usually a proportion of these are arrested in development, but the remainder enlarge, and in each, ten to sixteen refringent spherules of protein are formed in vacuoles in the cytoplasm. By this time the sporangium has reached a diameter of 0·25 to 0·3 mm.; its wall has become stretched, and at the point where cellulose was not deposited the wall eventually gives way, and the spores are launched into the tissues or escape through the ruptured surface of the polypus to the exterior. The spores which become lodged in favourable positions in the connective tissue grow, become sporangia, and produce a fresh crop of spores. Hitherto the nature of the spore has been misunderstood—the refringent spherules have been mistaken for spores. In view of the character of the nuclear divisions and the cellulose envelope of the sporangium, Rhinosporidium is regarded, not as a Sporozoon belonging to the Haplosporidia, but as belonging to the lower fungi (Phycomycetes) and in or near the Chytridineæ.—J. **Stephenson**: On some Scottish Oligochæta, with a note on encystment in a common freshwater oligochæte, *Lumbriculus variegatus* (Müll.). Descriptions of certain new and comparatively little known species of Microdrili are given; the limits of variability in certain organs and systems of the Enchytræidæ are discussed, particularly with reference to *Lumbricillus lineatus* (Müll.); and an account is given of the encystment of *Lumbriculus variegatus* (Müll.), a hitherto-unrecorded occurrence, on the margin of a Scottish loch in the dry summer of 1921.—Elsie I. **MacGill**: On the life-history of *Aphidius avenæ* (Hal.), a braconid parasitic on the Nettle aphis (*Macrosiphum urticæ*).

PARIS.

Academy of Sciences, October 30.—M. Albin Haller in the chair.—M. **d'Ocagne**: The plane representation of space.—M. **de Séguier**: The divisors of certain linear Galoisian groups.—C. **Camichel**: The turbulent regime. An account of some experiments on the turbulent flow of water in tubes.—M. **Maggini**: The rôle of anomalous dispersion in the spectra of stars. Displacements of lines in the spectrum of a star may be due to pressure, radial velocity (the Döppler effect), anomalous dispersion, or a difference in the potential of gravitation. Displacements have usually been attributed to the Döppler effect, but it is shown that certain cases are more probably due to anomalous dispersion.—R. **Goudey**: An annual periodic variation of the rate of a pendulum.—M. **Giacobini**: Observations of the Baade comet, made at the Paris Observatory. Positions of the comet and comparison stars given for October 23, 24, and 25. The comet is small, about 10″ in extent, and with a nucleus of about magnitude 12.—P. **Chofardet**: Observations of the Baade comet (1922c) made with the *coudé* equatorial of the Observatory of Besançon. Two positions are given for October 24.—A. **Schaumasse**: Observations of the Baade comet, made with the *coudé* equatorial of Nice Observatory. Positions of the comet are given for October 23, 26, 27. It was of 10·5 magnitude, with a nebulosity 1′·5 in diameter, and presenting an elongation in the direction opposed to the sun.—M. **Poivilliers**: A new "stereo-autograph." A description of a modified stereoscope which permits of the preparation by mechanical means of a plan showing contour lines or vertical sections from two photographs. The scale may be varied at will and the apparatus is suitable for railway surveys.—Louis **de Broglie** and A. **Dauvillier**: Analogies of structure between the optical series and Röntgen series of lines. From the point of view of Bohr's theory, the analogy of structure between the optical series and Röntgen series is explained by the fact that the internal levels, K, L, M, etc., respectively are characterised by the same total number of quanta as the first virtual exterior levels at the last electronic layer. These last levels are responsible for the optical series.—A. **Sellerio**: The axial effects of the magnetic field, analogous with those of Righi-Leduc and Ettingshausen.—Carl **Benedicks**: A study of the deformability of the photographic layer. It has been proved by astronomers that no sensible deformation of the photographic film takes place in ordinary star photography, but it is possible that the more intense light of the solar corona might produce a deformation and this would seriously affect such delicate measurements as the deviation of light passing through the field of gravity of the sun. The experiments described, designed to measure such a deformation, gave negative results, but the desirability of repeating the work with apparatus capable of giving higher precision is pointed out.—J. A. **Muller**: The degree of molecular polymerisation of substances at the critical state.—René **Dubrisay**: The action of boric acid on mannite in alkaline solution. To solutions containing equivalent proportions of boric acid and soda, increasing proportions of mannite were added and measurement made of the temperature of miscibility with phenol, the rotatory power, and the surface tension. No definite conclusions can be drawn from the experimental results. There always remains some soda uncombined, and there would appear to be at least two distinct compounds with mannite in the solutions.—M. **Bonnier**: The estimation of alkaline carbonates in presence of phenolphthalein. A statement of the

conditions under which solutions of carbon dioxide in caustic soda solutions can be titrated with accuracy. —L. J. **Simon**: The rôle of chromic oxide in oxidation with chromic and sulphuric acids.—Paul **Bertrand**: The coal flora of the Sarre coal measures.—R. **Legendre**: Diurnal variations of the hydrogen ion concentration of sea water near the coast. The hydrogen ion concentration of sea water taken near the coast varies during the day and passes through a maximum at about 3 P.M.—S. **Metalnikow**: Ten years' culture of infusoria without conjugation.—C. **Delezenne** and Mlle. Suzanne **Ledebt**: The transmission in series of the proteolytic power initially conferred on inactive pancreatic juice by enterokinase. —René **Wurmser** and Raymond **Jacquot**: The relation between the colloidal state and the physiological functions of protoplasm.—A. **Pézard** and F. **Caridroit**: Subrenal-testicular interpenetration in incompletely castrated cocks.—Edouard **Chatton** and André **Lwoff**: The evolution of the infusoria of lamellibranchs. The relations between the Hypocoma and Ancistrum. The genus Hypocomides.—Et. **Burnet**: The relations between *B. Abortus* and *Micrococcus melitensis*.—J. **Dumas**, D. **Combiesco**, and J. **Baltiano**: The action of the tetanic and diphtheric toxins administered by the mouth. Experimental tetanus can be produced in the guinea-pig by adding the tetanus toxin to the food, but the rabbit is resistant. On the other hand, the rabbit is more sensitive than the guinea-pig to the action of the diphtheric toxin administered in the same way. These results are not in agreement with the results of other workers, and this is explained by the author by the fact that his preparations contained more of the toxins.

Official Publications Received.

Zeitschrift für angewandte Geophysik. Unter ständiger Mitarbeit zahlreicher Fachgenossen. Herausgegeben von Dr. R. Ambronn. Band 1, Heft 1. Pp. 32. (Berlin: Gebrüder Borntraeger.)

Memoirs of the Indian Meteorological Department. Vol. 23, Part 3: Mean Monthly Characters of Upper-Air Winds deduced from the Flights of Pilot Balloons at Thirteen Stations in India during the Period 1910 to 1919. By J. H. Field. Pp. 41-136. (Calcutta: Government Printing Office.) 2 rupees; 3s.

Report of the Department of Industries, Madras, for the Year ended 31st March 1921. Pp. v+60+ii. (Madras: Government Press.)

Annals of the Transvaal Museum. Vol. 8, Part 4, containing Review of the Nomenclature of South African Birds, by A. Roberts; An Imperfect Skeleton of *Youngina Capensis*, Broom, in the Collection of the Transvaal Museum, by Dr. R. Broom. Pp. 187-276. Vol. 9, Part 1, containing Contributions to our Knowledge of the Dermaptera and Orthoptera of the Transvaal and Natal, by J. A. G. Rehn. Part 1: Dermaptera and Blattidæ. Pp. 99+4 plates. Vol. 9, Part 2, containing the Sphegidæ of South Africa, by Dr. G. Arnold; New Forms of Lasiocampidæ from the Transvaal Museum, by C. Aurivillius. Pp. 101-141. (Cambridge: Printed at the University Press.)

Transactions of the Rochdale Literary and Scientific Society. Vol. 14, 1919-1922. Pp. 128+xi+xi+xi. (Rochdale.)

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, St. Lucia, 1921. Pp. iv+31. (Barbados.) 6d.

Nigeria. Annual Report on the Forest Administration of Nigeria for the Year 1921. Pp. 18. (Ibadan.)

The Botanical Society and Exchange Club of the British Isles. Vol. 6, Part 3, Report for 1921. By G. C. Druce. Pp. 261-546. (Arbroath: T. Buncle and Co.) 10s.

Shall the State throw away the Keys? An Exposition of what Fine Chemicals mean to the Nation. Pp. 32. (London: Association of British Chemical Manufacturers, 199 Piccadilly.)

Diary of Societies.

SATURDAY, NOVEMBER 25.

ASSOCIATION OF SCIENCE TEACHERS AND THE ASSOCIATION OF UNIVERSITY WOMEN TEACHERS (at University College), at 11 and 2.30. —Joint Conference on the Teaching of Science in Schools and Colleges.

MONDAY, NOVEMBER 27.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Prof. R. F. A. Hoernlé: Notes on the Treatment of "Existence" in recent Philosophical Literature.

ROYAL SOCIETY OF ARTS, at 8.—Prof. W. A. Bone: Brown Coal and Lignites (Cantor Lecture).

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—Dr. P. Watson-Williams: Infections of the Teeth and Gums in relation to the Nose, Throat, and Ear.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—C. Gillman: An Ascent of Kilimanjaro.

TUESDAY, NOVEMBER 28.

ROYAL HORTICULTURAL SOCIETY, at 3.—M. B. Crane: Self-Sterility and the Pollination of Fruit Trees.

ROYAL SOCIETY OF MEDICINE (Medicine and Ophthalmology Sections).—Dr. B. Shaw, F. Moore, and others: Discussion on the Differentiation and Prognosis of Arterio-Sclerotic and Renal Retinitis.

INSTITUTION OF CIVIL ENGINEERS, at 6.—E. O. Forster-Brown: Underground Waters in the Kent Coalfield, and their incidence in Mining Development. (Continued discussion.)

INSTITUTE OF MARINE ENGINEERS, INC., at 6.30.—Film illustrative of the Conquest of Oil. Anglo-American Oil Co.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—J. E. Saunders: Off the Beaten Track at the Ipo.

SOCIOLOGICAL SOCIETY (at Royal Society), at 8.15.—H. Belloc: Factors of Historical Changes in Society.

WEDNESDAY, NOVEMBER 29.

NEWCOMEN SOCIETY (Annual General Meeting) (at Iron and Steel Institute), at 5.—At 5.30.—R. Jenkins: Notes on the Early History of Steel-making in England.

ROYAL SOCIETY OF ARTS, at 8.—Major W. S. Tucker: The Hot Wire Microphone and its Applications.

THURSDAY, NOVEMBER 30.

ROYAL SOCIETY, at 4.—Anniversary Meeting.

LINNEAN SOCIETY, at 5.—Dr. R. J. Tillyard: The Wing-venation of the Order Plectoptera, or May-flies.—D. M. S. Watson and E. L. Gill: The Structure of certain Palæozoic Dipnoi.

ROYAL SOCIETY OF MEDICINE, at 5.—Sir Almroth Wright: New Principle in Therapeutic Immunisation (Occasional Lecture).

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Dr. A. F. Tredgold: Some Problems relating to Mental Deficiency.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—W. A. Gillott: Domestic Load Building: a Few Suggestions upon Propaganda Work.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 6.—A. Whitwell: The Design of Spectacle Lenses.—Dr. M. von Rohr: On the Available Means for Correcting Considerable Cases of Anisometropia.—A. Whitwell: The Best Form of Spectacle Lenses for the Correction of Small Amounts of Anisometropia.—Dr. M. B. Dobson: Notes on the Non-operative Treatment of Squint.—O. Raphael: Standards of Accuracy for Ophthalmic Prescriptions.—W. A. Dixey: Some Recent Developments in Spectacle Lenses.—J. H. Gardiner: Sir William Crookes' Anti-glare Glasses.—H. S. Ryland: Methods used in the Manufacture of Gold-filled Spectacles and Clips.

CAMERA CLUB, at 8.15.—C. Robbins: A Peep at Prehistoric Man.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—Dr. Langdon Brown and others: Discussion on the Factors in Uræmia.

FRIDAY, December 1.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Dr. T. E. Stanton: Some Recent Researches on Lubrication (Thomas Hawksley Lecture).

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—H. G. Brown: Machines used in Magnetic Separation.

PUBLIC LECTURES.

SATURDAY, NOVEMBER 25.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—F. Balfour-Browne: British Water-beetles.

MONDAY, NOVEMBER 27.

UNIVERSITY COLLEGE, at 5.30.—Miss E. Jeffries Davis: The Evolution of London. Succeeding Lectures on December 4 and 11.

CITY OF LONDON Y.M.C.A. (186 Aldersgate Street), at 6.—Col. Sir William H. Willcox: Rheumatism and how to avoid it.

TUESDAY, NOVEMBER 28.

SCHOOL OF ORIENTAL STUDIES, at 5.—Sheikh M. H. Abd el Razek: The Study of Moslem Civilisation in Europe.

THURSDAY, NOVEMBER 30.

KING'S COLLEGE, at 5.30.—N. P. Jopson: The Distribution and Inter-relations of the Slavonic Peoples and Languages.

UNIVERSITY COLLEGE, at 5.30.—Dr. C. Pellizzi: Platone e l'Umanesuno (in Italian).

FRIDAY, DECEMBER 1.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 5.—Prof. T. Madsen: Specific and Unspecific Antitoxin Production (Harben Lecture).

BEDFORD COLLEGE FOR WOMEN, at 5.30.—Miss E. Jeffries Davis: Roman London.

SATURDAY, DECEMBER 2.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. E. Marion Delf: Vitamins and Health.

SATURDAY, DECEMBER 2, 1922.

CONTENTS.

Editorial and Publishing Offices:
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Smallpox and Vaccination.

THE present limited outbreak of smallpox in London gives point to the leaflet on smallpox and vaccination issued by the Research Defence Society. The widespread distribution of this circular would help in dissipating much misapprehension on the subject. Those requiring a more detailed exposition will find it in a recent report of nineteen pages issued by the Ministry of Health at the price of 3*d*.

The leaflet of the Research Defence Society points out that some fifteen million persons in England and Wales at the present time are unprotected against smallpox by vaccination. Figures are quoted illustrating the well-known facts that smallpox attacks chiefly the unvaccinated, that the fatality among unvaccinated is much higher than among vaccinated patients, and that practically no vaccinated child under ten years old suffers from the disease.

The supply of glycerinated calf lymph renders it impossible for either tuberculosis or syphilis to be conveyed by vaccination. This danger was always remote. It is now extinguished. The occurrence of complications after vaccination is avoidable if proper care and cleanliness are maintained. Yet a large proportion of the total population are unprotected by vaccination, and are dependent for their freedom from smallpox, on the prompt recognition and notification of every case of smallpox, on the intelligence and completeness of the work of the medical officer of health, and on the satisfactory working of every part of the machinery of sanitary administration which, almost times without number, has restrained outbreaks of smallpox within a small circle. This machinery comprises hospital isolation of patients, disinfection, a complete list and daily surveillance of contacts with the patient, and the surrounding of the patient with a complete ring of persons protected by vaccination, including sanitary inspectors, disinfectors, ambulance drivers, doctors, nurses, wardsmaids, and so on.

It is this ring of protected persons and the prompt vaccination or revaccination of all who have been exposed to infection which enables us to point to a record of smallpox prevention of which the country can be proud—a record in remarkable contrast to the national record as regards whooping-cough and measles. Every person vaccinated and revaccinated diminishes the strain on public health administration; and if this means of protection were to be systematically and universally adopted, smallpox hospitals would on longer be required.

Religio Chirurgi.

WE have received an address to theological students by that famous and well-beloved old surgeon, Dr. W. W. Keen of Philadelphia, the master and the representative of American surgery, whose work has long been honoured over here. He gives to his address the title "Science and the Scriptures"; but, of course, he is concerned with that hardship of thought which all of us confess. In America, he says, there is a mischievous "recrudescence of the warfare over Evolution": and he sets himself, by sixty-two years' study and teaching of anatomy and surgery, to confute such people as look for their science to the Book of Genesis, and say that man was "a separate direct creation." He finds it easy enough to establish a more reasonable view, and we over here can only wonder that it should now be necessary to do so. The distinctive mark of this address is, however, Dr. Keen's determined will to be as strong in the Christian faith as in his reasons touching evolution.

"I believe that man, himself, will only attain his final development in the future life beyond the grave. In that wondrous life I believe as fully as I do in my own present existence. . . . Bodywise, man is an animal, but, thanks be to God, his destiny is not the same as that of the beasts that perish. To develop great men, such as Shakespeare, Milton, Washington, Lincoln, and then by death to quench them in utter oblivion would be unworthy of Omnipotence. To my mind it is simply an impossible conclusion. Man's soul must be immortal."

Therefore, Dr. Keen invents a phrase that the moral and spiritual life of man has been "engrafted upon" his natural life. The phrase is, however, unsatisfying. Man's likeness bodywise to animals is acknowledged, but Dr. Keen evades the animal's likeness conductwise to man. What is the use of Shakespeare and Milton to us who do not admit any great difference or gap between animals at their highest and man at his lowest?

Doubtless, in this quandary, it may advantage us to remember that no science has anything to say about personality. There is a lot of slipshod talk about organisms; but not a word about the animal itself, the inscrutable person which is the cat or the dog, the very self which is "engrafted upon" the animal organism. Until we understand—which possibly we never shall—the mystery and secret of the creation of animals, we shall remain in a quandary that is too deep for scientific analysis. The only way of escape seems to be that which Dr. Keen has taken. It reconciles no difficulties. It holds things apart, not brings them together. Still, he is not the only man, full of age and experience, who has taken this way; and we may get, from his outspoken declaration of faith, a touch of that delight which Socrates always found in talking to old men.

Chemical Technology.

(1) *The General Principles of Chemical Engineering Design.* By Hugh Griffiths. (Chemical Engineering Library.) Pp. 63. (London: Benn Brothers, Ltd., 1922.) 3*s.* net.

(2) *Materials of Chemical Plant Construction—Non-Metals.* By Hugh Griffiths. (Chemical Engineering Library.) Pp. 64. (London: Benn Brothers, Ltd., 1922.) 3*s.* net.

(3) *The Weighing and Measuring of Chemical Substances.* By H. L. Malan and A. I. Robinson. (Chemical Engineering Library.) Pp. 63. (London: Benn Brothers, Ltd., 1922.) 3*s.* net.

(4) *The Flow of Liquids in Pipes.* By Norman Swindin. (Chemical Engineering Library.) Pp. 64. (London: Benn Brothers, Ltd., 1922.) 3*s.* net.

(5) *Pumping in the Chemical Works.* By Norman Swindin. (Chemical Engineering Library.) Pp. 80. (London: Benn Brothers, Ltd., 1922.) 3*s.* net.

(6) *Recent Progress in Rubber Chemistry and Technology.* By Dr. P. Schidrowitz. Pp. 64. (London: Benn Brothers, Ltd., 1922.) 3*s.* net.

IT was, we believe, Pascal who observed that knowledge tends to concentrate itself in little books. The half-dozen monographs, published by Messrs. Benn Brothers, of which the titles are given above, are at least an exemplification of the truth of this aphorism. They form members of a series intended primarily for the use of the chemical engineer. The information they afford is given in what may be called "tabloid" form. They are small octavo booklets of some sixty or seventy pages, and are suitably illustrated. The actual amount of letterpress is, therefore, very small. Still, small as they are, they are packed with useful data, and as they are compiled by authorities and are brought up-to-date, they will no doubt be found useful by the class of technologists for whom they are more particularly designed.

(1) "The General Principles of Chemical Engineering Design," by Mr. Hugh Griffiths, treats of the essentials of a successful chemical plant: its physical, chemical, and mechanical factors; its practical and economic factors; and the settlement of the final design in the light of experience of the working of these factors—a matter frequently of no small difficulty in view of the complexity of the problem. The book may be regarded as introductory to the series. It deals simply with first principles and generalities, illustrated here and there by facts based upon practical experience. It is well written and suggestive, but contains little but what a chemical manufacturer is already well aware of, from, it may be, a more or less painful experience. The little book would serve admirably as the intro-

ductory discourse to a course of instruction on the technique of chemical manufacture.

(2) In his little work on materials of construction Mr. Griffiths deals with facts rather than with principles. In his introduction he speaks somewhat contemptuously of the designing engineer who has but little knowledge of chemistry, and of the research chemist who is ignorant of even the most elementary principles of mechanics, both of whom know little or nothing of the behaviour of materials of construction towards the action of chemical substances under the special conditions of the manufacture, but who are yet called upon, one to design and the other to work the plant.

There is no doubt that in too many cases the strictures are well merited. So long as chemical manufacture is confined, as in the case of so-called "heavy chemicals," to comparatively few substances and those of a restricted class, the disastrous results, material and financial, of such ignorance are not likely to be very serious. But as the range of his work extends, the chemist is called upon to face an increasing complexity of conditions in manufacture, and he cannot be too well informed concerning the application of constructional materials to chemical plant: he must know, not only the usual influences of atmospheric action, weathering, rusting, etc., but also the effects of physical conditions and the specific action of substances in varying circumstances of temperature, pressure, catalytic influences, etc.

In the space of some six or eight short chapters the author deals with the properties of bricks and tiles, refractories; stone, natural and artificial; ceramic materials and glass; rubber, ebonite, leather etc., wood; and a variety of non-metallic materials, such as mortar, cement, lutes and jointings, paints and enamels. In the very limited space allowed to the author, the treatment is necessarily highly condensed, but it gives the essential facts accurately and in sufficient detail.

(3) The little book on "The Weighing and Measuring of Chemical Substances," by Messrs. Malan and Robinson, is concerned solely with these operations as they may, or should be, carried out in chemical works. It deals with the general mechanical principles and theoretical considerations applicable to the various types of instruments employed. These, of course, differ according to the physical nature of the substance to be weighed or measured, *i.e.* whether solid, liquid, or gaseous. All the commoner forms of apparatus are referred to, as well as those of modern type, some of which are of rather elaborate construction and need intelligent use. The booklet may be commended as a useful account of methods to be employed in checking the various stages of the production of a manufactured article with the view of economy and the prevention of waste.

(4, 5) The two books by Mr. Norman Swindin on the flow of liquid chemicals in pipes and chemical works pumping are concerned with associated subjects of great importance to the chemical engineer. In the first-named the general principles involved in the consideration of viscous flow—kinematic and absolute viscosity, the relation between mean velocity and velocity at axis of pipes, the practical application of the kinematic viscosity equation, the flow of liquids in channels, and pipe-line losses—are set out in such detail as the very limited space at the author's disposal permits.

Justice is done to the classical work of Osborne Reynolds and to the more recent investigations at the National Physical Laboratory by Dr. Stanton, and of Mr. E. Parry of the English Electric Company. In the discussion of the various formulæ for expressing the relation between viscosity and temperature, Rodger, the collaborator of Thorpe in their investigation of the connexion between viscosity and chemical constitution, is inadvertently spelt Rogers. The book concludes with a number of useful tables showing the viscosities at different temperatures and the densities of various liquids of importance in the chemical arts.

The booklet on pumping contains a description of the construction and mode of working of pumps employed in connexion with corrosive liquids—a problem of a very different order of difficulty compared with that with which the hydraulic engineer has usually to contend. The various types of pumps applicable to the conditions in chemical works are succinctly described with the aid of suitable figures and diagrams. Both books are useful compilations, and will be of service to the works manager and chemical engineer.

(6) Dr. Schidrowitz's little book on "Recent Progress in Rubber Chemistry and Technology" is a work of a very different order, and is in no wise connected with the Chemical Engineering Library. It deals more particularly with the extraordinary development of our knowledge concerning the nature of rubber, especially of plantation rubber, the conditions of its economical production, the mechanics of vulcanisation, the properties of vulcanised rubber, and the technique of rubber manufacturing processes—a development largely due to the creation of the tyre industry. Dr. Schidrowitz is an acknowledged authority on the subject of his book, and it is certain, therefore, to command the attention of all who are interested in rubber, whether as producers or as manufacturers. It is significant how little is heard to-day of synthetic

rubber; as a possible competitor of the natural variety its future appears hopeless. More plantation rubber is being produced than the world at present requires, or is likely to require for some time to come. At the same time, the investigations which have led to the synthesis of rubber, or of rubber-like substances, have great theoretical value, and have shed much light on the true nature and chemical constitution of this most remarkable substance.

Forward Progression.

Gaseous Exchange and Physiological Requirements for Level and Grade Walking. By Henry Monmouth Smith. (Publication No. 309.) Pp. viii + 310. (Washington: Carnegie Institution, 1922.) 6 dollars.

FORWARD progression, perhaps the form of muscular activity most commonly engaged in by the average human being, is, both in its anatomical and physiological aspects, one of extraordinary complexity. The work of Marey, Carlet, Braune and Fischer has thrown much light on the actual movement of the body and legs during the forward movement, and the researches of Zuntz and Schumburg, Durig, Douglas, Benedict and Murschhauser, and others have helped towards the elucidation of the metabolism and energy expenditure of the movement. A number of problems which have emerged from the previous investigations still remain unsolved; some of these questions are discussed, and in part elucidated, in this new volume from the Carnegie Institution's Nutrition Laboratory at Boston.

This book forms the natural sequel to the work of Benedict and Murschhauser. These workers dealt with the changes in the metabolism, the cost and the efficiency of the human body during horizontal walking. Monmouth Smith's work, although ostensibly it is meant to deal principally with "grade" walking, contains much new data on horizontal walking, more especially as regards the influence of the movement and change of position on the blood pressure, pulse and temperature. The effect of horizontal walking on the blood pressure is not great; as regards the pulse rate, one of the most striking features is the great variation found in the same subject under apparently identical conditions. In connexion with the rectal temperature several interesting facts emerge: (*a*) there is a definite lag in the rise of temperature which occurs in changing from standing to walking; (*b*) except at the higher rates the effect of the rate of walking is small; and (*c*) the maximum increase at any speed less than 100 metres per minute does not exceed 0·5° C. (without taking into consideration the duration of the exercise). Many new observations have also been made on the "step-lift." A slightly lower value for the cost of this operation than that of previous workers was found. A slightly lower value than that commonly accepted was also found for the energy cost per horizontal kilogrammetre.

In the grade-walking experiments a preliminary series of experiments were made on the influence of the mouthpiece on the breathing of the subject. These tests are of considerable technical interest. The general result is that unless the preliminary period of breathing with the mouthpiece in position be of sufficient duration, the accuracy of the determination of the respiratory quotient is endangered.

A large number of observations were also made on the influence of grade walking, in addition to the determination of the energy cost, on the blood pressure, pulse, pulmonary ventilation, and temperature. Those on the temperature are particularly interesting. It was found, for example, that the temperature increase was not always the same for the same amount of work, although, as might be expected, a higher temperature and a greater increase over normal were usually observed when the work and the metabolism were greatest. The maximum total increase, when the work done was heavy, was between 1·5° C. and 2° C. A number of very interesting experiments on the rate of the fall of the rectal temperature after the cessation of work are recorded. In one experiment at least it was very rapid, 1·14° C. in twelve minutes, or 0·09° C. per minute. On the other hand, if observations were continued, the rectal temperature was found to approximate normal pre-work temperature only about two hours after the cessation of work.

The Nature of Science.

What is Science? By Dr. Norman Campbell. Pp. ix + 186. (London: Methuen and Co., Ltd., 1921.) 5*s*. net.

"WHAT is Science?" is a question that may be answered in as many ways as "What is Truth?", and much depends on the questioner. In this case the original questioner was apparently an audience drawn from the Workers' Educational Association. Fifty or more years ago the worker was all agog for science; now, it appears, he either shoulders it aside as too academic for practical use, or rejects it as the "stone" of vocational education proffered instead of the "bread" of culture. The worker, in this limited sense, is not alone in misapprehending what is meant by "science," for the public at large, as recent years have given abundant proof, often blames it for sins

of both commission and omission, due really to human nature. It is well then that we should be provided in this handy form with a clearly-written and common-sense account of what scientific men mean by "science."

So much for the form of the answer. As for its content, Dr. Campbell will find one or other of his statements disagreed with by each philosopher in turn. But he refrains, wisely, from straying far along the perilous paths of metaphysics, and, while expressing his own opinion, admits frankly that there are others. If the question is to be answered by way of definition, Dr. Campbell's may be accepted as giving at any rate one point of view: "Science is the study of those judgments concerning which universal agreement can be obtained." In rebutting the objection that there cannot be universal agreement, Dr. Campbell selects as the most perfect example the order in which events occur. But have not some of the relativists suggested that agreement on this may not necessarily be universal?

Probably a definition is not the best way of answering the question. Dr. Campbell's definition may be true, but it does not cover the whole ground. It has one advantage, in that it omits reference to "the external world of nature," and that advantage is not merely metaphysical but practical, since without further discussion it permits one to include the study of the human mind and its products. It has been the attempt to define science by reference to its subject matter that has led to much of the misunderstanding. Science is, it seems to us, rather a way of looking at things or a method of study, and if it excludes any subject it is only because the method proves inapplicable. Undoubtedly a necessary condition is agreement upon the judgments. Take literature for example. Purely æsthetic criticism will never give that "Quod semper, quod ubique, quod ab omnibus" which science demands; and science therefore must decline to appraise the poetic merits of "Lear," "Hamlet," and "Macbeth." But the number of lines with weak endings in those plays can be ascertained definitely, and can therefore be subjected to scientific inquiry.

How science works is the subject of three chapters, which consider the nature, the discovery, and the explanation of the laws of science. We used to be taught that "a Natural Law is a regular sequence of Cause and Effect." Dr. Campbell discards the causal relation and replaces it by "invariable association." It is this invariability that lies at the base of the definition of science recently given by the Master of Balliol: "a body of generalisations from facts which enables us to predict fresh facts." But further inquiry shows that the associations, in their original sense, are not invariable. Exceptions arise and have to be met by new laws, either of the same kind or of a new type. The discovery of a new type of law is the privilege of genius. So far one may go with Dr. Campbell, but when he implies that the genius imposes the law in accordance with his "intellectual desires" and that "the universe obeys the dictates of [his] mind," it is not so easy to follow him. Does he mean that all our systems are purely subjective? To some extent the answer to this question is given in the section headed "Are theories real?" The reality of a theory depends on its power of predicting true laws, and thus it gains universal acceptance. "A molecule is as real, and real in the same way, as the gases the laws of which it explains. It is an idea essential to the intelligibility of the world not to one mind, but to all; it is an idea which nature as well as mankind accepts. That, I maintain, is the test and the very meaning of reality."

The position is intelligible, but our difficulties recur when we come to the interesting remarks on symbols and the æsthetic sense of the mathematician—"one more illustration of the power of pure thought, aiming only at the satisfaction of intellectual desires, to control the external world." Would it not be truer to say that the external world, by countless direct and indirect means, acting since life began, has so influenced the unconscious as well as the conscious perceptions of man, that the mind necessarily regards as harmonious those relations which conform to the seen or unseen reality of the universe? The scientific genius is he who has a deeper intuition of that harmony than his fellows, or, perhaps more accurately, he who can the most easily raise to the plane of consciousness the subconscious promptings of external nature.

Aspects of Military Medicine.

History of the Great War, based on Official Documents. Medical Services: Diseases of the War. Vol. 1. Edited by Major-General Sir W. G. MacPherson, Major-General Sir W. P. Herringham, Col. T. R. Elliott, and Lt.-Col. A. Balfour. Pp. viii+550. (London: H.M.S.O., 1922.) 21*s.* net.

UP to the beginning of the nineteenth century the medical history of wars was very incomplete, and is to be found in memoirs or commentaries written by individual military surgeons. To this category belong the works of Percy, M'Grigor, and particularly Barron Larrey, the great military surgeon of the Napoleonic period. A great change, however, took place with the publication by the Americans of the splendid and exhaustive "Medical and Surgical History of the War of Rebellion (1861–1865)," which has remained a model for all later works on military medicine. After the greatest of all wars it was to be

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expected that the medical histories which were bound to make their appearance would be voluminous and detailed, and that this country would not be behind others in this respect. The volume before us does not lead one to anticipate a standard work of permanent value in medical literature. From the brief preface, occupying a page and a half, it is not clear what the object of the work is. It is stated that the contributors had at their disposal the material contained in official documents, while later on it is said that "there has been little opportunity for further analysis and study of accumulated records of medical cases," and an apology is made that the contributors have been handicapped by the fact that papers published during the war were comparatively few. To any one conversant with the volume of medical literature which poured out in every country, this must seem an extraordinary statement. The "Index Medicus War Supplement," dealing with 1914–17, occupies alone 260 pages of titles, which at a conservative estimate represents at least 10,000 papers which were published on some aspect of military medicine during these three years.

Whatever was the intention of the editors, the book before us consists, in fact, of a series of short essays dealing with general statements rather than with actual data acquired during the war with respect to the several diseases of which they treat. Thus typhus fever and cholera are disposed of in sixteen and thirteen pages respectively, while the article on "General Aspects of Disease during the War" occupies less than ten complete pages. The other articles deal with such conditions as the enteric group of fevers, dysentery, cerebro-spinal meningitis, malaria, trench fever, jaundice, scurvy, beri-beri, pellagra, nephritis, and cardio-vascular diseases.

There are twenty-one contributors, and of these but four were regular officers in the army. It cannot serve a useful purpose to make an analysis of each of the individual articles. Many are sketchy, some are trivial, but those of Dr. Wenyon on malaria, of Sir W. Willcox on scurvy and beri-beri, of Sir J. Rose Bradford on nephritis, of Dr. Hume on cardio-vascular diseases, and of Col. Lelean on pellagra, are worthy of study. We are informed in the article on cholera that "all recent evidence shows that the cause of cholera is infection with the cholera bacillus." The word "recent" must here be taken as implying a period of nearly forty years.

The bibliographies in general are short, and some bear the impress of the professional copyist from the "Index Medicus" rather than represent the works consulted by the authors. In some cases the references given are to abstracts and epitomes and not to the original works, although the latter were easily accessible. References such as "Nicolot, Bour, Monier-Vinard and Buguet, Le Paludisine," without date or *locus* of publication, are not helpful to the reader. The coloured illustrations, six in number, are successful, but the index bears evidence of having been compiled by some one unfamiliar with this class of work. In future volumes it is to be hoped that some of the defects of this one will be rectified. Compared with the greatness of the subject, the appearance of the volume is not attractive. W. B.

Our Bookshelf.

Engineering Inspection. By Prof. E. A. Allcut and C. J. King. Pp. xv+187. (London: G. Routledge and Sons, Ltd., 1922.) 15*s.* net.

THE authors of the work under notice commence with a summary of the objects of inspection, and follow this by descriptions of inspection methods ranging from the inspection of raw materials to the carrying out of running tests on the manufactured product. These descriptions should make the book valuable to inspection staffs, who will find therein much of the information required in ordinary inspection work. In many cases references are given to original papers dealing with special methods of inspection, while the general information given in the text is amplified by a collection of useful tables in the appendix. In some respects the last chapter is the most important in the book, since it deals with the kind of temperament, as well as the qualifications, required in inspectors and viewers. Throughout the book the authors emphasise the point that the aim of an inspector should be to "scrap" as little work as possible, to detect faults in materials and workmanship at the earliest possible stage of manufacture, and to pass all sound work with the minimum delay. The type of organisation sketched out will be of interest to all engineers, and may indicate lines on which existing inspection systems can be improved; the general tone of the book should serve to remove much of the distrust with which inspection is still viewed by many. The authors are to be complimented on having presented so comprehensive a survey of an important subject in such a readable and well-balanced form.

The Emotions. By Carl G. Lange and William James. (Psychology Classics, vol. 1.) Pp. 135. (Baltimore, Md.: Williams and Wilkins Co., 1922.) 4 dollars.

WILLIAM JAMES and Carl Lange, investigating the problem of the emotions, independently and within a year, arrived at a very similar point of view with regard to the relation between the emotion as experienced by the subject and its bodily expression. The theory, generally known as the James-Lange theory, inverts the usual common-sense sequence which would say that we cry because we are sorry, and asserts that, on the contrary, we are sorry because we cry. Practically every student of psychology since the publication of the original articles has had to consider this conten-

tion; it is fairly easy to criticise, extremely easy to ridicule, and yet still remains provocative.

Very much more knowledge of the physiological processes concerned in emotion is available now, and although few thinkers could be found to accept the theory in its more extreme form, nevertheless it still has vitality.

The whimsical humour characteristic of James's writing arrested most readers' attention, and there seems little doubt that, although it in its turn had been stimulated by the work of Darwin, the publication of this theory gave considerable impetus to the study of the emotions and their relation to organic processes.

The present book, a reprint of James's and Lange's work, will be a valuable addition to the psychologist's library, presenting as it does, in convenient form, papers hitherto not easily obtainable.

A Manual of Clinical Laboratory Methods. By Prof. Clyde L. Cummer. Pp. 484. (London: H. Kimpton, 1922.) 28*s.* net.

DR. CUMMER has produced this manual for students and practitioners with the object of presenting clinical laboratory methods in concise and accessible form. The book is divided into seven chapters dealing with different materials—the examination of blood, of urine, of gastric contents, etc. In each, the methods of carrying out an investigation are first described, and the significance of the findings is then discussed.

The subject-matter of each section is well arranged, and there are numerous excellent engravings and plates; but there is much detail which could with advantage have been omitted. The method of using the inaccurate Tallquist hæmoglobinometer does not merit description in a text-book which aims at being concise; nearly half the book is devoted to the examination of the blood, and the chapter on urine is comparatively brief; the estimation of basal metabolism is not mentioned at all. The best section is that on cerebrospinal fluid, which contains good descriptions of modern investigations, including the Lange colloidal gold reaction.

The Teaching of General Science. By Prof. W. L. Eikenberry. (University of Chicago Nature-Study Series.) Pp. xiii+169. (Chicago, Ill.: University of Chicago Press, 1922.) 2 dollars.

THE rapid spread of the teaching of general science follows on the recognition of the educative value of the subject. Much of this is lost, so far as children are concerned, if the content is restricted to what may be useful for some of them in future training as specialists. "The preparatory values are incidental. The adjustment between general science and special science must be made by the latter building upon what foundation the former lays, rather than by any attempt to prescribe that certain materials shall be used for preparatory reasons." This is the main idea underlying Prof. Eikenberry's book, in which he describes the history and practice of the teaching in America. He has gone to the root of the matter, dealing fully with the principles on which practice should rest; and the result is a book which no one who has the interests of science teaching at heart can afford to ignore.

The Elements of Astronomy. By Prof. D. N. Mallik. Pp. viii+233. (Cambridge: At the University Press, 1921.) 14*s.* net.

THE problems of the diurnal rotation, meridian observations, the motion of the moon and planets, precession, nutation, refraction, etc., are dealt with in quite an elementary manner in the work under notice. The chief new feature is an interesting account of ancient Indian astronomy. The book is, unfortunately, greatly in need of revision, misprints, misspellings, and other errata being numerous. Some of them are likely to cause serious misconceptions; thus, the moon's distance is given as 23,800 miles, both on pp. 102 and 117. On p. 146 the distance of Europa from Jupiter is given as 9400 miles; on p. 138 the periodic time of a planet is stated to vary as r^3. It is difficult to suppose that the proofs were read with any care.

A. C. D. C.

The Iron and Steel Institute. Carnegie Scholarship Memoirs. Vol. 11: *The Corrosion of Iron.* By Dr. J. Newton Friend. Edited by George C. Lloyd. Pp. vi+161. (London: The Institute; E. and F. N. Spon, Ltd.; New York: Spon and Chamberlain, 1922.) 16*s.* net.

DR. FRIEND's collection of reports, dealing with various aspects of corrosion, does not represent a complete treatise on the subject. Many important researches and theories are not to be found in it, but the sections of the subject dealt with (including much of Dr. Friend's own work) are treated fairly fully. The subject of the corrosion of iron is one which has occupied man for some thousands of years, and a collected account of further progress will, therefore, be useful. Each investigator has usually emphasised one aspect of the process more than others, and in a "colloidal" theory of corrosion we recognise Dr. Friend's contribution.

Construction des réseaux d'énergie. Par M. Daval. (Bibliothèque Professionnelle.) Pp. 275. (Paris: J. B. Baillière et Fils, 1922.) 8 francs net.

M. DAVAL's work is written for those who have to design or superintend the working of electric power networks. It is written from a severely practical point of view, and assumes only the slightest mathematical knowledge on the part of the reader. The author lays particular stress on those practical points about which the academically trained engineer is often ignorant. The book is clearly written, and will be helpful to the junior staff engaged in the distribution of electric power.

Les Encres, les cirages, les colles et leur préparation. Par Maurice de Keghel. (Bibliothèque Professionnelle.) Pp. 384. (Paris: J. B. Baillière et Fils, 1922.) 10 francs.

REFERENCE has already been made in NATURE to an earlier volume of this encyclopedia. The subjects are treated from the technical point of view, *i.e.* recipes are largely given. Many of these would seem likely to be useful in the laboratory as well as in the workshop, and the book should fulfil the purpose for which it is intended.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Isotopes of Antimony.

OWING to the kindness of Prof. G. T. Morgan, who prepared a specimen of pure antimony trimethyl for this purpose, I have now been able to obtain the mass-spectrum of antimony. The element is characterised by two lines of nearly equal strength at 121, 123. The first is the more intense by perhaps 10 to 20 per cent. If sufficient exposure is given two faint companions are visible at 122, 124, but the general evidence suggests that these are due to hydrogen addition products. The isotopic nature of the lines 121, 123 is amply confirmed by the appearance of similar pairs 15 and 30 units higher, due to molecules of their monomethides and dimethides. The most trustworthy measurements show that the masses of the isotopes of antimony are most probably less than whole numbers by one to two parts in a thousand.

These results show that the chemical atomic weight 120·2 at present accepted is certainly too low. They are, however, in excellent agreement with the value 121·77 recently obtained in America by Willard and M'Alpine.

F. W. ASTON.

Cavendish Laboratory,
Cambridge, November 16.

Experiments on the Theory of Soil-acidity.

IN a recent paper "On the Adsorption of Ions" (*Phil. Mag.* (VI.) 44, 321) the origin of soil-acidity has been discussed (pp. 338-45, especially pp. 343-45). In the following a short account is given of some experiments carried out with Mr. Kamalacharan Bhattacharya and Mr. Bankim Chandra Roy.

It was suggested that the acidity is due to the adsorption by the gels (of silicic acid, aluminium oxide, and ferric oxide) of the anions of acids. The adsorption is so strong that the adsorbed substance cannot be washed out by water, and the aqueous extract is neutral. The anions are adsorbed on the surface by "chemical forces" whereas an equivalent number of cations forms the mobile second sheet of the double layer. If the cations consist in part of $H^{\cdot}$ ions, in treating with excess of a neutral salt (KCl) solution there is a displacement of the cations of the second layer by the cations of the neutral salt, as the latter is present in relatively enormous concentration, and as the forces acting on the cations of the mobile second sheet of the double layer are mainly electrical in nature.

Experiments have been carried out with powdered precipitates of silica, ferric oxide, and alumina. Of these, silica has been found to adsorb appreciable quantities of acids, *e.g.* acetic, citric, hydrochloric, and nitric. The adsorption is so strong that on repeated washing the adsorbed substance cannot be removed so that the aqueous extract soon becomes perfectly neutral. On now shaking the precipitate with KCl—which is tested with indicators to be perfectly neutral—the aqueous extract (free from particles of the precipitate) is found to be distinctly acid. The amount of the acid depends on the amount of the precipitate. In the extract with the neutral salt solution, acetates or citrates could not be detected.

The formation of insoluble salts of alkali metals or replacement of hydrogen ions by metallic ions in complex silicic acids is evidently out of the question. It is unanimously agreed that silica is an acid, and the probability of forming definite complex acids with acetic acid is very remote.

It might be argued that the acids are adsorbed as such, that is, the entire molecule is adsorbed. This point has been settled by simultaneous experiments on electro-osmosis. The apparatus used was a modification of that used by Briggs (*Journ. Phys. Chem.* 22, 1918, 256), which the writer found was employed by Dr. Ishikawa in the Physical Chemistry Laboratory of Prof. F. G. Donnan, University College, London. The sample of pure precipitated silica (British Drug Stores, Ltd.) we are using shows a marked negative charge in pure water. On treating with acetate the charge increases as shown by the rate of motion.

The results are accurate within about 10 per cent.

	Velocity in cm. per min.
Pure water	2 cm. ; 2·05 cm.
N/1000 sodium acetate . .	3·9 cm.
N/2000 acetic acid . . .	2·7 cm. ; 2·7 cm.
N/1000 sodium hydroxide .	3·4 cm. ; 3·2 cm.
N/100 acetic acid . . .	1·7 cm.
N/1000 hydrochloric acid .	2·3 cm.
N/1000 potassium chloride .	3·1 cm.

It will be seen that in the presence of sodium acetate and potassium chloride the negative charges increase 100 and 50 per cent. respectively. The experiments have been carried out under identical conditions. In the case of sodium acetate the presence of hydroxyl ions have to be taken into account. It will be seen, however, that acetanions are adsorbed to a greater extent than hydroxidions, and it is well known that the more strongly adsorbed substance largely displaces the other which is not so strongly adsorbed. In the case of potassium chloride the question of hydrolysis does not arise.

As is to be expected from the greater mobility of the hydrogen ions and the views of the writer (Far. Soc. Disc., Oct. 1921, *Phil. Mag.* (VI.) 44, 330-37), the acids of the same concentrations show a smaller charge than their salts. The charge is, however, undoubtedly greater than that with pure water, so that there is unmistakable evidence of the adsorption of anions, but owing to the effect of hydrogen ions the charge indicates a smaller adsorption than is really the fact.

We are at present engaged in working with the gels (which are likely to have greater specific surface) and with chemically pure silica or silicic acid gel. It appears that the electro-osmotic apparatus is also capable of further improvements.

These experiments clearly show that we are really dealing with the kinetic exchange of ions (hydrogen or $Al^{\cdot\cdot\cdot}$ in the case of soil acidity) in the second sheet of the double layer or present as electrically adsorbed, as suggested by the writer. It is not necessary to assume the hydrolysis of potassium chloride into alkali and acid in water, or the displacement of hydrochloric acid from alkali chlorides by humus acid, or the formation of insoluble salts of alkali metals, as has been done in the past.

There is other corroborative evidence in support of this point of view.

J. N. MUKHERJEE.

Physical Chemistry Department,
University College of Science, Calcutta,
September 20.

New Spectra of Water Vapour, Air, and Hydrogen in the extreme Ultra-violet.

AFTER reading of the excellent work of Prof. Wood on the extension of the Balmer series of hydrogen, I decided to investigate the Lyman series of hydrogen

in a similar manner. In the process of this investigation, some results were found which I now describe.

Water vapour in contact with films renders them insensitive to the extreme ultra-violet, and on the other hand, new films may be made sensitive for immediate use if they are thoroughly dried.

Water vapour gives a spectrum in the ultra-violet extending to about λ900. It consists of oxygen lines, hydrogen series lines, the secondary spectrum of hydrogen, and some bands probably not due to hydrogen. The A.C. or D.C. current used was found to dissociate water into its elements almost completely. A condensed discharge, however, formed compounds in the receiver of the vacuum grating spectrograph which fogged the films in the path of the light. It is, therefore, not surprising that a spectrum of water vapour should be found in this region of short wave-lengths, for hydrogen is known to be transparent here, and the author has shown (*Physical Review*, in press) that oxygen likewise is remarkably transparent in a portion of this region.

With condensed discharge and low pressure in receiver and discharge tube, a spectrum was obtained for air to λ350. In this experiment no attempt was made to eliminate mercury vapour. Many of the lines in the neighbourhood of λ600, recently found by Lyman to constitute a helium series, were also found on these films.

Ordinary commercial films were found sensitive at λ1215·7, so that a very clear line was produced on the film after only five minutes' exposure, with hydrogen at a pressure of 0·3 mm.

Using wet hydrogen and a long discharge tube three new members of the Lyman series of hydrogen were found. Thus there are now six lines of that series known. Appearing on the same spectrogram with these was a line λ243·2 ± 0·2. This was observed on many films, and on some of them it occurred in the first, second, and third orders. Its wave-length agrees within limits of experimental error with the equivalent wave-length (λ248) for the L critical potential of oxygen, observed by Kurth, using photoelectric methods. The observation of this line in hydrogen at a pressure of 0·3 mm., after the light had traversed a distance of one metre, shows the transparency of hydrogen in this region. This fact may be useful to those working in soft X-rays or in the region of these short ultra-violet radiations. Furthermore, the presence of this line indicates that the great absorption band of hydrogen which begins at about λ850 terminates on the long wave-length side of λ243.

J. J. HOPFIELD.

Department of Physics, University of California, Berkeley, October 30.

Molecular Viscosity.

THE following remarks are offered rather in the nature of a foreword, suggesting a particular line of research, than as an article of belief. Although the conclusions arrived at are purely theoretical, and have at present no experimental confirmation, the practical test outlined at the end of the paper should supply a definite answer as to whether there is any foundation for the theory advanced.

Our conception of the physical forces which are called into play when a liquid is caused to flow with linear or stream-line motion is gradually undergoing a change. The old definition of viscosity as internal friction needs revising. Already Dunstan and Thole (Journ. Inst. Petr. Tech., vol. iv. p. 197) have come to regard viscosity in the nature of a dual phenomenon, which they attribute partly to internal friction and partly to deformation of molecular grouping (although these may conceivably be one and the same thing). There is one aspect of the subject which does not seem to have received its fair share of notice. Allusion is made to the gyroscopic resistance offered by any orbits, the motion of which has components at right angles to the line of flow.

When a vapour condenses into a liquid, the molecules still retain the major portion of their high velocity; and since it is only their mutual attraction that prevents them from escaping again into space, it follows that their paths must be very curved, and that in all probability there will be at any instant of time a certain number of them revolving round one another in orbits, after the fashion of the twin stars. These systems would doubtless have only a short life, being destroyed by collision with neighbouring molecules, but for the instant of time during which conditions were favourable similar orbits would be formed to take their place.

For want of a better name this particular form of viscous resistance will be referred to as gyro-viscosity. We may then consider the property, common to all liquids, of resistance to flow as made up of at least two parts, namely:

(a) gyro-viscosity.
(b) molecular friction or deformation.

Whereas (a) lends itself readily to mathematical treatment, (b) is still so largely a matter of conjecture, that while our ideas are in their present state of flux, we cannot be sufficiently definite about anything in this connexion to attempt any sort of analysis. We can, however, be moderately confident that in some degree (a) must obtain, and it is hoped to show a means whereby it may be measured. When a liquid is subjected to a shearing stress, in other words when flow starts, there will be at once the gyroscopic resistance of those components of the orbits at right angles to the line of flow; and when these have been turned through a right angle and flow continues there will remain the constant resistance of those orbits which are produced during flow. Viewed in this way the initial momentary resistance should be greater than the subsequent constant resistance; and since the former is independent of the rate at which the orbits are being formed, it would afford a means of estimating the relative molecular gyro-viscosity, if only it could be measured with sufficient accuracy. A method of doing this which suggests itself is based upon the correct resolution of the forces which go to produce the so-called Couette correction for flow through capillary tubes.

Couette found that when the length l of the tube was doubled the corresponding time t was not quite doubled, and that in order to satisfy his equation it was necessary to replace l by $l+kd$, where d is the diameter of the capillary and k a constant having an approximate value of 0·25. Since this correction is, in a sense, a measure of the total work W_o done *outside* the tube, it must contain also the preliminary work W_m required to turn all the orbits in existence at any instant of time in the whole volume run. The difference $W_o - W_m$ represents the work done *outside* the tube in overcoming viscous resistance of the liquid *already in motion* (the kinetic energy correction was, of course, allowed for, and therefore does not enter into these quantities).

The Couette value affords a direct means of determining W_o but the calculation of $W_o - W_m$ presents considerable difficulties. We are faced with the problem of finding (1) an expression for the distribution of the velocities in the trumpet-shaped lines of flow of the liquid before it enters the tube; (2) the *varying* acceleration of any one of these lines before it attains its final constant velocity on entering the

tube; (3) the influence of the head of liquid on the curvature of these lines. As all of these admit of exact mathematical treatment, it should be possible, by running a gram-molecule of the liquid, to calculate W_m. This would be entirely independent of the velocity of flow and would represent the relative molecular gyro-viscosity. Whereas the ordinary figures for absolute viscosity appear to bear no general relationship to the other physical constants of the liquid, it is possible that these values might be more productive of results. A thorough investigation of these lines of flow is therefore the first necessary step towards the solution of this most interesting problem. FRANK M. LIDSTONE.

37 Powell St., Derby,
November 1.

New Weights and Measures for India.

I HAVE read with interest the article in NATURE of September 2, p. 325, on the weights and measures of India by Mr. Silberrad, president Indian Weights and Measures Committee. Mr. Silberrad reports conditions much the same as I found them in India in 1910. One of the pleasures in reading NATURE is that the desirability of producing commodities and methods of service is taken for granted. Now in attacking this problem it is assumed that a simple, useful system of weights and measures is desired for India. While in India I was asked to rewrite the article on weights and measures for the "Times Year-book," and in looking up data in this connexion, I came across the permissive Metric Act of 1871. This Act represents one of the attempts of the leaders of India to secure the advantages of the general use of the metric system. By it the Viceroy of India is empowered to make what preliminary arrangements might be necessary, and proclaim the date after which metric weights and measures shall come into general use.

Let us consider the various necessary units of measurement in their logical order.

1. Mr. Silberrad rightly mentions "the Peshawari yard of 38 in. to 38¾ in.," and also the yard of approximately 40 inches. Also the Ilahi gaz, which is frequently in the neighbourhood of, if not exactly, 39·37 inches or one metre. These are only a few examples of units of length in a country of approximate lengths that could be best standardised on the international metre.

2. Practically the same thing is true of measures of area. Nearly all of the British engineers that I have met have favoured the metric system, and few have any desire to continue the use of such a difficult unit as the acre. The square metre and the hectare of 10,000 square metres are good and sufficient, and will, we believe, be used eventually in all civilised countries. Several of the Indian units fortunately approximate to the hectare.

3. The suggestion that "the standardisation of suitable measures of capacity at the nearest suitable multiple of the bulk of 1¼ seers of water, this being approximately equivalent to the bulk of a seer of wheat," is not so unfortunate as it may seem. This probably will soon become the litre.

4. My findings also correspond with those of Mr. Silberrad in reference to the tola of 180 grains, about 12 grams. This brings the seer to approximately 1 kilogram. When it is understood that the seer has been adopted for practically all railroad transactions in India by the British Government, one realises that India is using the metric system in what amounts to 60 per cent. of all accurate transactions according to weight.

It was my pleasure to spend part of the past summer in England, and confer in regard to the metric campaign with members of the Decimal Association and others who are actively interested in the metric movement. I found a general desire to secure the advantages of decimal currency and metric weights and measures. It was forcibly brought home to me that the chief men of England who have the vision of service and big foreign trade will not only encourage the Colonies to make progress in the metric movement, but will also see to it that the British Government leads the way in this much-needed reform. Readers of NATURE will be interested to see the following statement by Prof. J. C. McLennan of Toronto University: "In the early part of 1906, at the request of the Hon. L. P. Brodeur, Minister of Inland Revenue of the Dominion Government of Canada, I agreed to deliver a number of lectures on the use of metric weights and measures.

"Through the co-operation of the Department mentioned, a schedule of the lectures was arranged, and it was made known in various centres throughout Canada that my services in connexion with the metric campaign would be available on certain dates for the various local societies interested in this subject.

"In carrying out this rather strenuous schedule, lectures were given in Montreal, Ottawa, Toronto, Winnipeg, Regina, Vancouver, and in over 30 other Canadian cities. In some places the idea of the simple metric system corresponding to decimal currency was then new to many people. Our meetings were well attended, in some cases as many as 600 people being present. At the close of each address, all present were invited to take part in the discussion of the subject. The pros and cons were propounded with the utmost frankness, and in some cases with considerable vigour. Never during this lecture tour or at any other time have I heard, in so far as I can judge, a really valid argument against the general use of metric weights and measures. On the other hand, the many valid reasons for their use increase as time passes.

"It is highly desirable that this preliminary educational work, conducted entirely at the expense of our Government, should be effectively followed up. It is chiefly for the purpose of encouraging others to do their part in securing for Canada the advantages of the use of the metric system that on April 28, 1922, I accepted the Chairmanship of the Toronto Section of the American Metric Association. At that time Mr. W. P. Dobson of the Hydro-Electric Power Commission was elected Secretary, and Mr. L. Burpee, of the Canadian General Electric Company, Ltd., was elected Treasurer. Our Section is composed of volunteer workers, who desire to see the metric campaign progress as it should. We believe that everybody can do something to help. We hope that a great many people will let Mr. Dobson know that they will help the metric movement in their own industry or line of work."

It may seem a far cry from Canada to India, but there is a direct connexion when one realises that the various peoples of the world can understand and serve each other best when they use the same convenient weights and measures. The members of the American Association are determined to secure these advantages in the United States and Canada, and we ask for the hearty co-operation of all progressive men and women throughout the world.

HOWARD RICHARDS
(Secretary).

American Metric Association,
156 Fifth Avenue, New York.

BY the courtesy of the Editor I have read Mr. Richards's letter, and think that he and I disagree solely by reason of the difference in our Indian experiences. If it were a case of starting with a clean sheet there would be no greater difficulty in adopting the metric system than in adopting any other; but this is not the case. The British yard *has become* very widely known, whereas the metre is quite unknown. The Peshawari yard and the Ilahi gaz, themselves variable units, are used only to a comparatively small extent, while the most widely known unit of length, the hath or cubit, is very near to half the British yard, and as a matter of practical fact this measure is regarded as representing it exactly.

Similarly, the acre *has now become* very widely recognised and used as a unit of area, while the hectare has scarcely even been heard of.

It is true that the 80-tola seer (of 14,400 grains) is near the kilogram, but it is not exactly equal thereto, and to change it would, as a matter of practical fact, involve altering the weight of the rupee, as that coin is universally recognised as representing in weight 1 tola. This question of changing the weight of the rupee so as to give a seer of exactly two pounds, or else of 1 kilo, was one that the Weights and Measures Committee considered very carefully and on which it recorded much evidence, and (the majority of the members) reluctantly came to the conclusion that any alteration —whether in weight or value—of that coin would give rise to so much suspicion as to make it more than doubtful whether such a change would be worth while.

It has taken fifty years to spread the knowledge of the 80-tola seer to the extent now achieved; to introduce a new unit would mean starting all over again, and the same remark applies to any change in the units of length or area.

I have no doubt that engineers would prefer the metric system—so would I, personally. But the people of India are not engineers. Ninety per cent. of them live in villages or small towns of less than 5000 inhabitants, and are only interested in weights and measures being true and uniform within the limited range of their journeyings. For one transaction in which it would be an advantage to use a world-wide system, there must be at least 10,000 in which it would be of not the slightest advantage.

Mr. Richards refers to Canada. I imagine that it would be difficult to find two peoples more absolutely different than those of Canada and of India; the Canadian is well educated and progressive, the Indian, as a rule, very poorly educated, and intensely conservative. It would be difficult to conceive of widespread lecturing on weights and measures in India; audiences might perhaps be secured in half a dozen of the largest towns, but nowhere else, and the population of India is more than thirty times that of Canada. (I do not wish to imply that Mr. Richards thinks lecturing advisable, but merely to emphasise the difference between the two countries.)

My own experience of India at the time of the Weights and Measures Committee was twenty years in the Civil Service, all on the executive side, in the course of which I usually spent four to six months every year on tour among the villages and small towns of my district; that of my Indian colleague on the Committee (who shared my views, with very insignificant exceptions) was very similar. With this experience we disagreed from our other member, and held that there were not sufficient advantages attached to the metric or other non-Indian system to justify us in making a recommendation which, if accepted, would affect the method of carrying out an enormous number of petty transactions, and could be given practical effect only by a large amount of interference. Now interference of such a kind as would be required to enforce the use of a new system of weights and measures means interference by a large and therefore necessarily low-paid staff, and what that means any one with Indian executive experience knows, for though the head of the Indian Government colossus *may* be golden, its feet *are* very certainly still decidedly argillaceous!

In brief, we found a very general desire for a uniform system of weights and measures, but for one based on a unit that was known, and hence we recommended that system which could be adopted with very much less difficulty than any other.

C. A. SILBERRAD,
President Indian Weights and Measures Committee, 1913–14.

Harpoons under Peat in Holderness, Yorks.

ON page 481 of NATURE for October 7, Mr. O. G. S. Crawford states that he believes one of the alleged harpoons said to have been found under the peat in Holderness to be genuine. At the Hull Meeting of the British Association he thought that both were genuine. After the spade-work to which he refers, I feel satisfied that he will consider both of them are modern. I am also glad to learn that he now regards the evidence supplied by the flint axe to be of no value, whereas formerly he considered that it helped to prove the great age of the harpoons.

As one who knows Holderness fairly well, I should like to ask what evidence there is for the statement that "There can be little doubt that in Holderness exist remains of the early neolithic age, remains which are older than the Long Barrows"? At Hull we were promised that a committee should be formed to inquire into the question of the harpoons. I have heard nothing further about it, but trust such a committee may be called together.

If I have cast doubts upon the authenticity of implements which have been accepted as genuine by quite a number of authorities, and my doubts prove to be unfounded, I deserve censure. If, however, the statement I made proves to be correct, the facts should be published, in the interests of truth.

Reasons for my belief are given in a communication which I sent to the Editor of *Man* a little while ago, as Mr. Armstrong's illustrated description of the harpoons first appeared in that journal. I do not remember having made the statement in public that the harpoons had been "*made* by the supposed finder." I did say they were not as old as Mr. Armstrong.

T. SHEPPARD.

The Museum, Hull.

The Relationship between the common Hermit-crab (*Eupagurus bernhardus*) and the Anemone (*Sagartia parasitica*).

THE relationship between the common hermit-crab (*Eupagurus bernhardus*) and its messmate anemone *Calliactis* (*Sagartia*) *parasitica* has long been a subject of much conjecture, owing largely, the present writer thinks, to the unnatural figures of these animals in all the text-books and most popular books—derived probably from old and abnormal aquarium specimens. In most figures purporting to show the relationship of these animals, the anemone is shown with its tentacles beautifully expanded and the mouth region facing *upwards* away from the ground, and generally

also one anemone as the central figure sitting on the top of the shell—containing the hermit-crab—with its column extending high above the shell and crab.

When these hermit-crabs with their associated anemones are caught fresh in the trawl it may be observed that although the anemones come up closed in no case are they sitting on the shell as is shown in the well-known figures; on the contrary, whether there is only one or as many as three anemones on a shell they are all found to be either hanging from the shell with the disc region towards the ground or are straining their bodies to reach their discs over the side of the shell towards the ground (see Fig. 1). In order to obtain more information, a collection of fresh hermit-crabs and anemones was obtained by trawling in September 1920 and a few experiments made in a tank. The hermit-crabs and anemones were isolated and kept without food for a few days, in the course of which most of the anemones closed. At 11.30 A.M., September 22, the crabs, carrying altogether 18 anemones, were fed with cockles and queens. At 12.5 P.M. all anemones were open with their discs and tentacles spread flat out on the bottom of the tank (as is shown in Fig. 1) and being trailed about in this position by the crabs. At 10 A.M., before the feeding, two anemones were closed, three already had their discs on the ground, and thirteen were held horizontally from the apical region of the shell-house of the crab, and at 1 P.M., after feeding, many were again closed or with their bodies held horizontally. On September 29 the experiment was repeated, but this time fresh dredgings only were thrown into the tank. All the anemones soon put their discs flat on the ground, and those which were sitting horizontally bobbed their discs down on the ground within a few minutes, almost as though the order "heads down" had been given and obeyed. It was not possible to see whether the unusual movements of the crabs on the addition of food, or the smell of the added food, caused the anemones to react as they did.

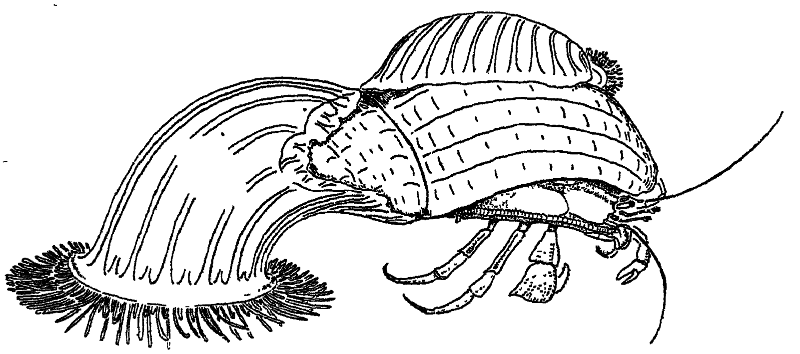

FIG. 1.—Drawing from life of the Hermit-crab (*Eupagurus bernhardus*) in a shell of the common whelk with two anemones (*Calliactis parasitica*) shown in the natural feeding position, and with the commensal worm (*Nereis fucata*) in the act of taking food out of the jaws of the hermit-crab. (About half the natural size.)

On adding the food to the tank it was also observed that the worms (*Nereis fucata*) living in the shells inhabited by the hermit-crabs also came out to feed. The hungry worms came out cautiously some time after the hermit-crabs had begun to feed, and in one case a worm was observed to crawl alongside the body of the crab (see Fig. 1), over the active mouth appendages, and literally to take with impunity a piece of food from between the jaws of the crab and bolt it. There seems to be little doubt that this action of the worm is consciously tolerated by the hermit-crab, as it was observed that the crab can apparently control the exit of the worm from the shell. It was found, however, that strange worms taken from other hermit-crab shells are not regarded in a kindly manner by either the anemone or the crab: worms fed to anemones are eaten, and worms straying in the neighbourhood of hermit-crabs were mercilessly torn up and tasted but rejected as food. The spectacle of a hermit-crab cleaning itself after feeding is a revelation of the value of spines and hairs and of the meticulous cleanliness of these animals, and cannot fail to impress the observer with the pleasure—and even mild intoxication—experienced by the hermit-crab from the feed.

It is clear that the anemone derives advantage from the hermit-crab by getting dragged about with its tentacles on the ground and being given opportunities for picking up pieces of food left or lost by the hermit-crab and for capturing other animals as food. The hermit-crabs were not seen to pass on pieces of food definitely to the anemones, but there would always be a good chance of an anemone getting some food from the table of the hermit-crab, owing to the habit of the latter of tearing the food apart.

The crab itself probably derives some measure of protection from attacks from fishes owing to the unpleasantness of its associated anemones as food, but it is well known in this laboratory that the common ballan wrasse (*Labrus bergylta* (*maculatus*)) will watch its opportunity to seize a large claw of a hermit-crab and shake it—like a dog worrying a rat—with the common result of extracting the whole hermit-crab out of the shell-house without touching the anemone.

The function of the worm in the shell can scarcely be guessed at, but the curious and constant wave-like motion of the whole body of the worm—which can be seen by making a window in the shell—will certainly keep up a strong current of water around parts of the body of the hermit-crab, and may assist the hermit-crab in this way in the aeration of its body or in the removal of effete products. The advantage to the worm of obtaining shelter and of partaking of the hermit-crab's food is obvious.

J. H. ORTON.

Marine Biological Laboratory, Plymouth,
November 9.

First Lessons in Practical Biology.

AFTER being encouraged by favourable criticism, both from the Press and from private individuals (not in all cases personal friends), I was somewhat surprised at the acerbity of the attack, published in NATURE, November 4, upon my unpretentious book "First Lessons in Practical Biology." Helpful criticism is welcome to an author, and the correction of errors can be the making of a second edition of a text-book; but adverse criticism in which personal bias of opinion is allowed to outweigh generally accepted beliefs can have little value either for the author or for the reading public.

If "the telson is *not* a segment" I am consoled by the thought that two such standard works as "Practical Zoology" (Marshall and Hurst) and "Biology" (Parker) contain the same heresy. If "the biramous appendage is *not* the primitive form of crustacean appendage" I have still to read a more convincing argument than that given in the "Cambridge Natural History (Crustacea)."

I conclude that the critic was so pained by my restricted use of the term "embryo" (as applied to plants) that he failed to read to the end of the chapter; otherwise he would not have stated that "experiments on plant physiology are not reached until chapters 16 and 17." I agree that it is desirable to introduce plant physiology at an earlier stage in the course; but, with the exception of *germination* (which is introduced in the Easter Term), the experiments seldom yield good results in the winter months. The school year begins towards the end of September, and the arrangement of the chapters (as stated in the preface) was based upon this assumption.

E. W. SHANN.

Oundle School, November 10.

I REGRET that Mr. Shann regards my review of his book as an "attack," and yet more that it calls from him the word "acerbity." The need for brevity compelled, perhaps, a certain bluntness; and I beg him to accept my assurance that it was solely to my regard for space in your columns that any such bluntness was due. It was from like considerations that I was obliged to refrain from indicating the authority for and adducing evidence in support of some of my criticisms.

With regard to the telson and biramous appendage I adhere to my statement. If Mr. Shann will refer to p. 144, § 2 *c* of Marshall and Hurst (9th edition, 1920), he will see that the telson is spoken of as a "region" of which a "segment" is a part. On referring to the passage in my copy of the "Cambridge Natural History" I find that when I first (presumably in 1909) read its discussion of the relative claims of the biramous and foliaceous limb to be regarded as "primitive," I wrote in the margin "All the facts here stated, if taken in the reverse order, support the opposite theory." This is equally true to-day. If Mr. Shann will read H. M. Bernard's "The Apodidæ" (Macmillan, 1892) I shall be astonished if he does not abandon the biramous as the "primitive" form of crustacean limb.

I duly noted that the course was arranged with the view of beginning in the Michaelmas Term; but as the very next sentence in the preface suggests modification of the order "at the discretion of the teacher," I felt justified in directing attention to the tardy appearance of plant physiology. The fact that some physiological experiments occur as early as chapter 14 does not seriously affect my criticism.

THE REVIEWER.

The Mechanism of the Cochlea.

IF I understand Dr. Perrett's letter in NATURE of November 11, p. 633, his objection to Yoshii's experiments (which would apply equally to those of Wittmaack and Siebenmann) is based on the assumption that the intensity of the stimulation of every part of the cochlea must be proportional to the amplitude of the vibration set up in that part. I think this assumption is unwarranted, as the intensity of the sensory impression may vary also with the rapidity and the rate of change of direction of the movement imparted to the cilia of the hair-cells; *i.e.* as the total energy of the stimulus, not its amplitude only. Even supposing Dr. Perrett's assumption were correct, still Yoshii's deductions are not invalidated. Take the case in which he found that after prolonged subjection to high-pitched noise the basal portion of the cochlea showed degeneration. He deduces the logical conclusion that a high-pitched note stimulates the basal portion of the cochlea. It does not matter whether the stimulus thus applied were small as compared with that produced in the apical region by a prolonged low note or not. The apical region remained unaffected because it was not stimulated at all.

I cannot say that my model shows the shifting of the responses according to the intensity of the stimulus that Dr. Perrett says it should do, and possibly my knowledge of physics is insufficient to enable me to appreciate the reasons which lead him to look for this result. Personally, I have very little faith in the "crucial test" method of solving the problem of sound perception. The question has already been so long and so keenly debated, and so many "crucial tests" have been applied on both sides of the argument, that one almost begins to doubt the possibility of tone perception at all.

I have read Sir William Bayliss' letter (p. 632) with great interest. Naturally, it is very gratifying to me to find that my view of the mechanism of the cochlea has the support of so distinguished a physiologist. I am not very sanguine that my model will throw much light on the more refined details which he gives of the working of the cochlea. What the model actually shows is a definite, though not always well-defined, series of responses at different points along the "basilar membrane" for vibrations varying in frequency from about 100 to about 1000 D.V. per sec., the higher notes being at the proximal and the lower at the distal end of the scale. More than this I cannot claim for it. The mechanical difficulty of setting up a series of short threads, evenly spaced, evenly graduated in tension, and maintaining their spacing and tension unaltered during and after the processes of fixation, embedding and immersion in fluid, is so great that I have not succeeded so far in attaining anything approaching accuracy.

One need scarcely say that so imperfect an apparatus cannot, in its present state, throw much light on the more recondite points. If on the other hand we concentrate our attention on the more obvious, and more fundamental factors, I think the model does give some help. We recognise in the basilar membrane of the cochlea a threefold differentiation of its fibres, for length, tension and mass, and this differentiation is progressive, and in the same sense for each factor. We can embody those mechanical factors crudely in the form of a working model, and we get some sort of remote and inaccurate representation of what happens in the cochlea. The effects observed are undoubtedly resonance effects. It follows that the same resonance effects must take place in the cochlea. One cannot understand how Nature could evolve so elaborate a mechanism of resonance as we find in the cochlea, except by means of, and for the purpose of, increasingly accurate analysis of sound.

G. WILKINSON.

387 Glossop Road, Sheffield, Nov. 15.

An Offer of *Nature* Volumes.

THE writer has been entrusted with the disposal of thirty-three volumes of NATURE (unbound, as issued) which their owner wishes to present to some library in the war-devastated area. These consist of vols. 50 to 56, 74 to 92, 97 and 98, and 103 to 107. A few parts are missing. Should any reader of NATURE know of some one who may be communicated with for this purpose, the information would be gratefully received.

M. GHEURY DE BRAY.

40 Westmount Road, Eltham, S.E.9, November 13.

Human Blood Relationships.

THE idea that a loss of blood by hæmorrhage or the possession of blood of a poor and deteriorated quality might best be rectified by the introduction into the body of blood from a healthy person is of respectable antiquity. It is small wonder that the ancients attributed to so splendid and conspicuous a tissue an importance rather beyond its due. About the time of the fire of London Pepys attended experiments in which the blood of one dog was passed into another and found to be sufficient for its needs, and on another occasion at which a man was hired for a sovereign to have some sheep's blood let into his body. For even at this time it was realised that some sorts of blood were more suitable for transfusion into man than others. Little boys might be bled to death in the fifteenth century to provide stimulating potions for aged Popes, but human blood seems scarcely to have been available in Lower's time, and the choice generally fell on the sheep, partly because of its gentle and amiable disposition and partly "quia Christus est agnus Dei," as Coga said, an indigent bachelor of divinity who subjected himself to the experiment in 1667. But transfusion of blood never became an important or popular therapeutic procedure on these terms; large quantities of foreign blood were found to cause serious and even fatal ill-effects and small amounts did no good. With the discovery of the last thirty years that the tissues of any one species of animal are foreign and more or less poisonous to the economy of any other species came the recognition that transfusion in man could be done only with human blood, and in recent years the value of the procedure has been fully established, large quantities being transfused from a healthy to a sick person without untoward effect.

In this revival of human transfusion it was, however, soon found that the capacity of the body to identify any blood as foreign to and incompatible with its organisation was based on finer distinctions than zoological species. If from a dozen people a few cubic centimetres of blood are withdrawn, and in each case preparations made of the serum and of the red corpuscles washed free from serum, and if a sample of each lot of corpuscles is then mixed with a little of each serum in a series of test-tubes, it will be found that the results are not all the same. In some the corpuscles behave as if they were suspended in physiological salt solution—remain dispersed from one another and intact; in other cases they run together into larger or smaller clumps and masses and often disintegrate. It is obvious that the occurrence of this agglutination in the circulating blood is very undesirable, as the masses of corpuscles are liable to block important blood-vessels, and there is plenty of experience to show that serious trouble may be caused in this way. It is therefore not every human blood that is suitable for transfusion into a given person.

By sorting over a large number of people by this test it has been found that they may be classified into four groups by the satisfactory hypothesis of von Dungern and Hirschfeld. On this view there are two agglutinating factors in human blood serum (*a* and *b*) and two agglutinable factors (A and B) in human blood corpuscles: A corpuscles will react only with *a* serum, *b* serum only with B corpuscles. A is never found in the same person as *a*, nor B with *b*; either combination would be incompatible with life. The blood characteristics of the four groups are:

	Serum.	Corpuscles.
Group I. . .	neither	A and B
Group II. . .	*b*	A
Group III. . .	*a*	B
Group IV. . .	*a* and *b*	neither

It follows that the serum of Group I. will not agglutinate anybody's corpuscles, while the corpuscles of Group I. are agglutinated by all other sera except their own. Group IV. is the reverse of this, while the serum of Group II. agglutinates the corpuscles of Groups I. and III., and the serum of Group III. the corpuscles of Groups I. and II. The corpuscles of Group I. can safely be put only into recipients belonging to the same group, those of Group II. only into Groups I. and II., those of Group III. only into Groups I. and III., those of Group IV. into anybody. It is a curious fact that in actual practice it is only the qualities of the donor's corpuscles and the recipient's serum which need be considered. When, for example, Group IV. blood is transfused, the plasma of it should agglutinate the corpuscles of the recipient if the reaction took place as it does outside the body. This does not appear to happen, or if it does it produces no obvious ill-effects—which is fortunate, as otherwise safe transfusion would be impossible except between members of the same group. Why this should be so is at present doubtful. It is most probably due to the quantity of transfused plasma being insufficient, when diluted with the recipient's blood, to cause a significant agglutination of the recipient's corpuscles. The fact that it is plasma which is injected and not serum may also have some influence, though the recipient's plasma has the same effect as his serum, at any rate qualitatively.

While it is convenient to recognise four varieties of individuals, it will be seen that there are only two factors concerned. A is characteristic of Group II., and B of Group III.; A+B are present in Group I., and both are absent in Group IV. A corpuscles are necessarily associated with not-*a* serum, and B corpuscles with not-*b* serum. In inheritance these qualities have been shown to be transmitted as straightforward Mendelian factors. It follows that the blood of parents and children are by no means necessarily compatible: though parents both of Group IV. can produce children only of the same group, two Group I. parents may have offspring belonging to any group, according to the particular composition of their hybridity. The possibility of using these blood reactions to investigate cases of disputed parentage has been carefully worked out by Ottenberg, who shows that the method can have but a limited application, though the answers are conclusive if they can be obtained at all. Of much interest also is the observation that the proportion of the population falling into Groups II. and III. varies a good deal in different races. In England about 40 per cent. are Group II., about 15 per cent. Group III., Groups I. and IV. giving about 2

and 43 per cent. respectively. Several workers, and especially the Hirschfelds, have shown that as one travels from west to east the prevalence of Group II. (A) decreases and that of Group III. (B) progressively rises. In Western Europe, A is found in about 45 per cent., in Russians and Arabs in 37 per cent., in negroes and Indians in 27 per cent. B, on the other hand, increases from about 15 per cent. in France, through the Balkans (20 per cent.), Malagasies (28 per cent.), negroes (34 per cent.) to Indians with 49 per cent. We have here an obvious suggestion of two original races of mankind, which have mingled in various degrees: it is possible that in some remote place a pure A or B variety still exists.

At present there is no evidence that these blood characteristics are associated with any other qualities, and it seems likely, like some other Mendelian characters, that they are negligible in the problems of selection and survival. It would, too, be an error of the ancients to suppose that the qualities of the blood dominated personality and conferred a general characteristic on the individual. There is much evidence of the essential similarity of parents and offspring. The greater success of grafting tissues from one animal to another if they are of the same family is a germane example. In blood tests brothers and sisters by no means always agree so far as the agglutination of their corpuscles is concerned: in other respects their bloods are probably more similar than those of more remote relations.

The History of the Photographic Lens.

DR. REGINALD S. CLAY performed a needed and useful service when he selected for the subject of the twenty-fifth annual Traill-Taylor Memorial Lecture, which he delivered at the meeting of the Royal Photographic Society on October 10 last, "The Photographic Lens from the Historical Point of View." It was a needed service, because a historical review of the origin and development of the photographic lens is necessary for a just estimate and balanced perspective of the many and diverse scientific factors that have to be taken into account in the production of modern photographic lenses. It was a useful service, because the fascinating and, at times, almost dramatic story that Dr. Clay had to tell brings out clearly the paramount importance of the pioneer work done in this field by British firms and scientific workers, and it must act as a useful corrective to the tendency, sometimes manifested in unexpected quarters, to underrate the value of British work in the optical field.

After touching lightly on the early history, Dr. Clay comes to "one of the great landmarks in the history of optics—the invention of the achromatic lens." John Dolland, after numerous experiments, exhibited to the Royal Society an achromatic prism in 1758 of crown and flint glass, and explained its construction. Of the authors who contributed, in this period, before the invention of photography, to the theoretical treatment of the lens, Dr. Clay instances, after Kepler, the following:

Huygens, who, besides expounding the wave theory of light and the explanation of double refraction, also dealt with the spherical aberration of lenses, and showed how it varied with their aperture and focal length; Newton, who investigated the dispersion of light; Joseph Harris, who discussed the cardinal points, optical centre, oblique pencils, curvature of field, etc., in his "Treatise of Optics"; Herschel, who obtained valuable equations for the calculation of objectives free from chromatic and spherical aberration; George Biddell Airy, who investigated the conditions for eliminating astigmatism and distortion; William Hamilton, who evolved powerful mathematical methods which even yet have not been fully utilised; and, last but not least, Henry Coddington, who worked out the methods which, I believe, still form one of the most useful bases for attacking new problems in lens construction.

The next milestone marks the almost simultaneous announcements of the inventions of photography by Daguerre in 1838 and Fox Talbot on January 30, 1839, and we reach "the epoch from which we may date the great evolution of the photographic lens." After referring to the photographic lenses of Charles L. Chevalier, Dr. Clay comes to the work of Josef Max Petzval (1807–1891), who computed a new and most successful lens, corrected for spherical aberration over a small angular field, which was made by Frederick Voigtländer in 1840.

We may pass over much interesting record and come to a new chapter, opened in 1866 with the aplanatic lenses of Steinheil and Dallmeyer. Steinheil, "beginning to recognise the value of symmetry in reducing astigmatism and distortion," concluded that the astigmatism would be less if the refractive indices of the glass were more nearly equal; he therefore used two flints instead of flint and crown, putting the higher refractive glass outside. Dallmeyer also used two flints, and called his first lens a "wide-angle rectilinear lens," 1866. It worked at f/15, and he followed it by his symmetrical at f/7 and f/8. In 1874 Steinheil made a portrait lens of two cemented lenses working at f/3·5, and in the same year Ross brought out their portable and rapid symmetrical, calculated by F. H. Wenham. "This is of interest," says Dr. Clay, "as Ross and Co. (as the firm then was) was thus the first firm to employ a scientific man as calculator. Wenham was with them from 1870 till 1888."

The next step, which Dr. Clay describes as "the greatest step in the development of the photographic lens," was made possible by the new glasses—the barium crowns of the Schott glass factory at Jena. The problem and its solution is thus expressed:

An achromatic lens of ordinary crown and flint, which we may call an "old achromat," could be corrected spherically, but not made anastigmatic. An achromatic lens made of the new barium crown and a flint could be corrected for astigmatism, but not spherically. To correct both, all three glasses must be used—old crown, flint, new barium crown. To take full advantage of this principle, it is obvious that each component can be made of all three glasses. It can then be achromatic, anastigmatic, and aplanatic. By combining two such components into a symmetrical lens, it can also be made orthoscopic, and can easily be given a flat field. This is the principle underlying the well-known Goerz lenses. Another way to achieve the result is to use two unlike combinations, one of which is made responsible for

correcting the spherical aberration and the other for correcting the astigmatism. This is usually the method adopted by Rudolph in the earlier of the Zeiss lenses and several of the recent lenses by other makers.

Hugo Schroeder and Stuart, of Ross and Co., were the first to take advantage of the new Jena glasses, and in 1888 they patented the "concentric" lens, composed of a flint and a barium crown. It was corrected for astigmatism, but had a lot of spherical aberration. Dr. Clay reviews briefly the series of Zeiss lenses—Planar, Protar, Unar, and Tessar—made by Ross under license, and in this connexion tells the following significant story:

In 1911, when Zeiss had finished their factory at Mill Hill, they gave Ross notice to terminate the license, and themselves made the Tessar—the only one of which the patent was still running. This is rather an illuminating fact. It must be remembered that in 1892, when Ross started making the Zeiss lenses, Ross had a great name as makers of photographic lenses, while Zeiss's were practically unknown in that connexion, and undoubtedly Ross's reputation helped to make the new lenses known; yet no sooner are Zeiss ready to make their lenses over here than they terminate the contract! No further comment is necessary.

An interesting summary follows, which we have not space to notice in detail, of a brilliant series of lenses produced by Ross from 1892 to the present day. Dr. Clay says: "One other achievement of this firm I must refer to. When the Air Force began to take aerial photos in the war they found the Ross-Zeiss Tessar, of 8½-in. focus, suitable, but soon wanted great numbers, and also asked for a longer focal length lens with perfect definition over a small angular field, *e.g.* a 20-in. lens to be used with a 5 by 4-in. plate. This was wanted urgently, and in a single fortnight the lens was recalculated, and the 'Airo-Xpres' lens evolved in November 1918, working at f/5·6. Messrs. Taylor, Taylor and Hobson also made a variety of the Cooke lens, the 'Aviar,' for the same purpose."

We have not space to deal more than hurriedly with the fascinating record that Dr. Clay gives of the other work done in Britain in the development of the photographic lens to its present stage of wonderful achievement. An interesting account is given of the lenses introduced by the firm of Dallmeyer, and special attention is directed to the striking advance represented by their telephoto lenses. The original patent for the telephoto was taken out in 1891. Another English firm, R. and J. Beck, Limited, it is interesting to note, were the first to apply the iris diaphragm to photographic lenses, as early as 1882. In 1906 Beck introduced their "Isostigmar Universal," and in the following year their Isostigmar portrait lens. "These lenses do not obey the Petzval condition—that the sum of the power of the lenses, divided by their refraction index, should be zero—and were constructed by omitting this from consideration, as they believed it was not essential for a flat anastigmatic field"—a view afterwards confirmed by the investigations of W. Elder. The Isostigmar is of interest, as it covers a field of 85 to 90 degrees at f/16, the first wide angle with such an aperture. Beck also introduced another simple idea—the use of magnifiers in front of a lens—made for their Frena camera in 1894.

We have left till the last not the least of the British achievements in the development of the photographic lens—the Cooke lens invented by W. H. Dennis Taylor and made and put on the market by Taylor, Taylor and Hobson, Limited. Dr. Clay says: "I do not think the great step which the Cooke lens marks is as well appreciated here as on the Continent. The introduction of this lens has formed the starting-point for a new method of lens construction which has had, and will continue to have, many fruitful applications." The germ of the invention is thus expressed by Dennis Taylor:

It . . . occurred to the author that since the normal curvatures of images due to any lens, whether simple or compound, are fixed by its refractive indices and power alone, and are independent of the state of rays entering the lens, whether convergent, divergent, or parallel, then it should follow that the normal curvature errors of an achromatic and aberration-free collective lens should be neutralised by the normal curvature errors of an achromatic and aberration-free dispersive lens of the same power (and made of the same glasses), placed at a considerable distance behind the collective lens; while the combination would, *as a result of the separation* . . . yield a positive focus. . . .

The patents for the Cooke lens were taken out in 1893, 1895, and 1898. During the war the special Aviar lens, referred to above, was evolved, designed by Arthur Warmisham of Taylor, Taylor and Hobson. It is a split-divergent lens, which was a conception of the inventor of the Cooke lens, but the exploitation of the idea was left to Warmisham, who was able, by making a special study of coma, to improve upon the large aperture Cooke lenses, and secure a flat field of larger area than had hitherto been found possible.

In a brief review of Dr. Clay's lecture we have had perforce to omit much of important interest, but we may conclude by re-echoing the words of the author: "In this story I think we in Britain may claim that we have borne our share, in spite of all the praise that has been lavished on the Germans."

Obituary.

Prof. Heinrich Rubens.

Heinrich Rubens was born at Wiesbaden on March 31, 1865, and received his early training at the *Realgymnasium* at Frankfurt on the Main, where he gained the School Leaving Certificate, equivalent to Matriculation, in March 1884. In the summer term of that year he proceeded to the Technical High School at Darmstadt to take up the study of electro-technics. During the following winter term and the summer term of 1885 he continued his studies at the Technical High School at Charlottenburg, but soon recognised that his ability and interest lay in the domain of pure science, and for this reason he began the study of physics. After spending the winter term (1885–86) at the University of Berlin, Rubens passed on to Strass-

bourg at Easter of the latter year to work under August Kundt. He followed Kundt to Berlin in May 1888, and obtained his Ph.D. there the year following. His early post-graduate career was spent as *Assistent* under Kundt at the Physical Institute of the University of Berlin, where he remained until 1896, when he was invited to the Charlottenburg Technical High School, and in 1900 he was officially elected professor at that institution. In the autumn of 1906 he was elected to a full chair of experimental physics at the University of Berlin, and to the directorship of the Physical Institute, which posts he filled during the remainder of his life. He died of leuchæmia on July 17 last.

Rubens was a member of the Berlin Academy of Science, and of many other similar bodies in his own country and abroad, including the Royal Institution, of which he was an honorary member. He held doctor's degrees (*honoris causa*) of the Universities of Leeds and Cambridge, and was a recipient of the Rumford Medal of the Royal Society.

Most of Rubens' scientific investigations were concerned with the infra-red region of the spectrum, and the logical connexion of his numerous researches is a noteworthy feature of his scientific activity. Many of the instruments used in the prosecution of his work were of his own construction, including the Rubens thermopile, and the Rubens-Du Bois spherical sheath galvanometer. He was led to the discovery of residual rays as a result of his work and measurements on the optical properties of various substances with regard to heat rays. He succeeded in reducing the previously unexplored region of about twelve octaves (from $\lambda=0{\cdot}005$ to 50 mm.) between the infra-red region of the spectrum and electrical waves, by his discovery of about seven of the missing octaves.

After his observation that a number of minerals strongly reflect infra-red waves of certain definite wave-lengths, and transmit the rest of the rays, Rubens was able to isolate rays up to a wave-length of about 0·01 mm. Repeated reflection of the radiation from such surfaces results in a residual radiation which contains certain definite wave-lengths only; *e.g.* from fluorspar (0·022 and 0·033 mm.), rock salt (0·052 mm.), sylvine (0·063 mm.), potassium bromide (0·083 mm.), potassium iodide (0·094 mm.). In part collaboration with Wood, Rubens isolated still greater wave-lengths by the quartz-lens method, in which, by virtue of the higher refractive index of quartz for these long waves than for the shorter infra-red and visible rays, and by the use of suitable diaphragms, he succeeded in obtaining rays with a wave-length of about 0·110 mm. from an incandescent mantle. Using a quartz mercury lamp he extended this limit to beyond 0·3 mm. In continuation of his earlier measurements on wave-lengths in the near infra-red, Rubens and his co-workers examined the dispersion and absorption of the whole range of the infra-red in numerous substances. By making use of the refractive indices of numerous substances found for these long wave-lengths, or the values extrapolated for infinite wave-length, he tested the validity of Maxwell's law ($n^2=k$) between the refractive index for these waves, and the corresponding dielectric constant of the substance in question. Several series of measurements on the absorption of infra-red waves in water vapour supplied him with the material requisite for the comparison of Bjerrum's theory of rotation spectra with experiment, and for calculating the main moment of inertia of the water vapour molecule.

In addition to his fundamental work on residual rays, Rubens accomplished much in other branches of radiation. He carried out measurements in collaboration with Hagen at the *Physikalisch-Technische Reichsanstalt* on the reflecting power (R) of metals, which led to the empirical result that for metals the coefficient of penetration ($P=1-R$) for very long waves can be represented by the relation $P=0{\cdot}365\sqrt{\sigma/\lambda}$, where σ is the specific resistance of the metal, and λ the wave-length of the rays in terms of the unit 0·001 mm. This result is in agreement with deductions from the electromagnetic theory of light. His investigations on the validity of the law of radiation are of primary importance. Conjointly with Kurlbaum he carried out measurements on black body radiation of long wave-length, and this work was largely responsible for a revision of Planck's first radiation formula, and thus supplied one of the experimental bases of the quantum theory. Only last year, Rubens again applied his great experimental ability in an endeavour to test Planck's law of radiation in its final form. The results of this work led to the complete confirmation of the theory. They were communicated to a Congress of Physicists at Jena in the autumn of 1921, and Rubens was acclaimed by the congress in a manner seldom met with in scientific life.

Rubens, whose wife survives him, was in failing health for some years prior to his death. To those who knew him well, it seemed that the privations attendant upon war-time conditions were in a large measure responsible for hastening the end. In addition to his great powers and achievements, his active nature and kindly disposition bound him closely to his colleagues, who realise that in Rubens they have lost much more than a valued colleague. The loss to science will be appreciated by those of other countries who came in contact with him, for one could not meet Rubens without feeling the forcefulness of a striking personality. Until his death he maintained none but the friendliest of feelings towards his colleagues in England, and during the long years of the great war he took a human interest in the well-being of those of our scientific nationals whose lot it was to be detained in enemy territory. For these he did what he could. Science mourns his loss, and the record of his active life will occupy a prominent place in the annals of science.

R. W. L.

THE opportunity is most welcome to add my expression of deep regret for the loss of Prof. Rubens at an age when much might still have been expected from his scientific activity. I well remember the enjoyment of the hospitality of himself and his family in days now past, in the residence attached to the Physical Institute of the University of Berlin, where memories of Helmholtz were evoked at every turn. One can recall the simplicity of the apparatus used in his personal investigations, in keeping with the directness of his main results. In these respects he retained throughout his career the stamp of the school of his early master Kundt.

The existence of sharply defined ranges of intense

optical reflection, even of the metallic type, from some crystals had been known and understood in its main features for a long time.[1] It was left for Rubens to develop it into what amounted to a new kind of spectrum analysis for invisible rays far down in the infra-red, by sifting the radiation by successive reflections. By this means he discovered and isolated precise narrow bands of dark radiation (*Reststrahlen*) very remote from the visible spectrum: just what was most needed at that time for the wider verification and consolidation of ideas regarding the general laws of radiation. In collaboration with Rubens in these investigations his friend E. F. Nichols first made his mark, soon to be followed up at home in America.

In later years by use of the *Reststrahlen* he was able to discover that in metals the defect from perfect reflection, for radiation of great wave-length, depended on their conductances alone. This was readily intelligible in a general way: for the square of the complex index of refraction for rays of frequency $p/2\pi$ is of the form $K - 4\pi c^2 p^{-1}\sigma\iota$, and as both terms of it are found to be effective in metals for ordinary light, the second term, involving p^{-1} and the specific conductance σ, must predominate far in the infra-red. But the entirely unexpected feature was that the agreement was so close that optical observations by themselves could give a good value for the ordinary conductance σ of a metal for continuous currents. In other words, the response to electric force in metals is so prompt that the mechanism of conductance becomes completely established within the fraction 10^{-13} of a second of time, thus giving an essential datum for the understanding of the process of transfer of electrons in metallic bodies.

The decisive completeness of this incidental verification of the Maxwellian scheme of radiation naturally attracted general attention, in its contrast with the long years that elapsed in the early time before the cause of the imperfect correspondence of the refractive index with $\sqrt{K}$ for transparent media was fully appreciated.

One was struck with the ease and simplicity of Rubens' modes of thought. The problems which he wished to attack came naturally to him, without any incrustation of theoretical complexities. Like Faraday and many another experimenter, he was an example of how far simple physical intuition could lead. The directness and cordiality of his personal qualities must have won and retained the regard of all who knew him.

JOSEPH LARMOR.

[1] Cf. *ex. gr.* Stokes in discourses at the Royal Institution and to the Chemical Society, as early as 1864: "Math. and Phys. Papers," vol. iv. pp. 244, 261.

LIEUT.-COL. G. L. TUPMAN.

LIEUT.-COL. GEORGE L. TUPMAN, who died at Harrow on November 4 at an advanced age, was for many years a devoted amateur astronomer. He was elected a Fellow of the Royal Astronomical Society in 1863, being one of the oldest Fellows at the time of his death. He was on its council from 1873 to 1880, and secretary from 1884 to 1889. His earliest astronomical work was on meteor radiants; he made numerous observations of meteors while on service in the Mediterranean, 1869–1871, and published a catalogue of radiants in Mon. Not. R.A.S., vol. 33. Tupman observed the transits of Venus in 1874 and 1882 from Honolulu and New Zealand respectively. He worked for some time at Greenwich Observatory as a volunteer, both in preparation for the transits and in their subsequent discussion; his preliminary result from a discussion of the 1874 transit, $8''\cdot813$, is very near the value now accepted. Since many of the stations were dependent on lunar observations for longitude, he studied carefully the errors of the lunar ephemeris from the results of all the leading observatories.

Tupman had a well-equipped observatory at Harrow, with two equatorials, reflector and refractor, and a transit circle. He made many meridian observations of stars, also occultations (especially during the lunar eclipses of 1884, 1888, 1895 for the determination of the moon's diameter), comets, transit of Mercury, etc.; he also frequently invited other astronomers to use his instruments.

A. C. D. CROMMELIN.

H. J. POWELL.

BY the death of Harry J. Powell, on November 26, at the age of sixty-nine years, the country has lost one of the earliest pioneers in the scientific manufacture of glass. For some years he lived in the works at Whitefriars, and during this time, and for many years afterwards, he superintended personally the weighing out and mixing of the material for the next week's batch of glass. For forty-five years he was making experiments with the object of improving the quality of the flint glass made at Whitefriars, and attaining perfection of colour in the glasses. These have led to the magnificent results seen in the windows of the cathedrals of Salisbury, Liverpool, and New York, and in those of many churches in this country and abroad. He not only improved the nature and colour of the glass, but he was a designer of the first rank. Few of the art museums of this country are without specimens of his artistic skill.

Mr. Powell was well known to most scientific men, and was always ready to put his knowledge and technical skill at their disposal. The vacuum flask, the idea of which was conceived by Sir James Dewar, was made first by him, and it was to his experiments that the success of Sir William Crookes's cerium glass, for cutting off the ultra-violet and heat rays, was mainly due. At the outbreak of war, foreseeing the shortage of glass for chemical purposes, he worked out, in conjunction with his son-in-law, a soda-lime glass with very great resistance to changes of temperature and action of water. This glass was used by the Admiralty for the construction of the horns of submarine mines.

Mr. Powell retired from the business three years ago, and devoted his time to an attempt to make generally known the results of his knowledge and experience. He worked up to the last, the final revision of a book, "Glass-making in England," and of an article for Sir Richard Glazebrook's "Dictionary of Applied Physics," in which he propounded a new theory of the origin of colour in glass, being completed only a few days before his death.

BY the death of Dr. Herbert Langton on October 12, in his seventieth year, the Museums Association loses its honorary treasurer, the museum sub-committee of Brighton its chairman, and the British Ornithological Union a valued member. A portrait appears in the *Museums Journal* for November.

Current Topics and Events.

THE dyeing of artificial silk at one time presented many difficulties, which have, however, been overcome so far as the silk made by the Chardonnet and Viscose processes is concerned. On the other hand, the new "acetate silk" does not lend itself with equal readiness to the dyeing operation and, hitherto, some difficulty has been experienced in producing an adequate range of fast and pleasing colours. The "acetate silk" arose as an outcome of the war, when the general opinion was reached that the method of the Dreyfus Brothers for producing aeroplane dope from acetyl cellulose was the best. The large factories which were then built for the preparation of this substance had, when the war ceased, to turn their energies for the most part into other directions, and the manufacture of artificial silk was one of these. The silk is of great lustre and beauty, but as the composition of the acetyl cellulose remains unaltered even in fibre form, it does not possess any marked affinity for that large and important class of colouring matters which are substantive to cotton. This affinity can, however, be imparted to the fibre if conditions are present which cause it to undergo hydrolysis in the dye-bath, and Prof. A. G. Green, working in the Research Laboratories of British Dyes Ltd., has now succeeded in isolating a new and curious series of colouring matters which are apparently particularly suited for the purpose of dyeing acetate silk. These colouring matters belong to a class of compound which is readily hydrolysed in solution, and in that form can be fixed on the acetate silk. Moreover, the "Ionamines," as Prof. Green has named the new colours, can be made to possess a diazotisable amino group, and many beautiful shades can be obtained by diazotisation and development on the fibre. It follows also that, since the ionamines possess no affinity for the cotton fibre, it is possible to dye a fabric composed, for example, of cotton and acetate silk, two colours in one bath. Thus, in a bath containing a mixture of chlorazol green BN (a substantive cotton dye) and ionamine KA, the cotton will be dyed green and the acetate silk red. The effects, which are very striking, should go far to render the new silk popular.

AN International Aeronautical Exhibition will be held at the Grand Palais, Paris, during the second half of this month, commencing on December 15. As is to be expected in view of the great interest aroused by the remarkable records set up during the past few months, particular attention will be devoted to motorless or wind flight. Gliders that were used in the recent contests will be exhibited, including the machine in which Maneyrol so dramatically beat the German duration record, just at the end of the gliding week on the South Downs. A particularly interesting feature of the exhibition will be the attempt to illustrate the scientific principles underlying wind-flight, both as regards the results already achieved and the problems that yet remain to be solved. Thus, in addition to showing the wings of such birds as the albatross, eagle, condor, etc., the promoters will illustrate the way in which the presence of wind renders motorless flight possible. Such winds are (1) vertical convection currents in the air due to the sun's heat; (2) upward currents due to the existence of undulations in the ground, like hills and valleys, the main feature of the flights executed during the past few months; and (3) varying horizontal currents, which are known to aid motorless flight. Some use of the latter appears to have been made in a recent flight in Germany.

A FILM record of the Mount Everest Expedition of 1922 was shown for the first time at a joint meeting of the Royal Geographical Society and the Alpine Club held on Tuesday, November 21, at the Central Hall, Westminster. The film, which is one of exceptional interest and permanent value as a record of life in Tibet and the conditions of mountain exploration in 1922, is the work of Capt. J. B. L. Noel, who succeeded in operating his kinematograph at an altitude higher by many thousands of feet than any to which such an instrument has previously been carried. He made sure of good results by developing his films, under great difficulties, partly in a tent by the Rongbuk glacier torrent at a height of 16,500 feet, and partly in a dark room he built in the old fort at Gyantse. The conditions were such that when the film was wet it froze; when dry it sparked with the slightest friction and could not be kept free from dust. In spite of these difficulties, however, a good film-record was obtained. The subjects of the film include the scenery of the forest belt beyond Darjeeling; the bare and dry plateau of Tibet; the mode of life of the Tibetans; the Rongbuk monastery with its sacred Lama and ritual dances; the approach to Mount Everest along the Rongbuk glacier; and the assault on the mountain by the climbing parties, by way of the North Col. The effects of the terrible wind, flinging clouds over the North Col and tearing the snow from the mountain, were well shown on the film. Capt. Noel took his kinematograph to Camp III. (21,500 feet), and, using a telephoto lens, photographed the descent of the first climbing party, who had discarded oxygen and reached a height of nearly 27,000 feet. He ascended to Camp IV. (22,500 feet) on the North Col with the second party, who carried oxygen, and photographed them next day during the first 2000 feet of their ascent to 27,235 feet, the highest point reached. The Mount Everest Committee has arranged for the film to be shown to the public for a season at the Philharmonic Hall, as well as in the principal cities of Great Britain. The proceeds will be devoted to the cost of a third expedition.

IN his interesting and suggestive presidential address to the Surveyors' Institution on November 13 Mr. J. McClare Clark discusses the effect of post-war conditions on agriculture and shows that the sequence of events since 1918 is exactly parallel to that after 1818, and that in many respects events of 1922 closely resemble those of 1822. During the

Napoleonic wars the prices of wheat rose enormously; in 1800 it was 113s. 10d. per Imperial quarter. Under this stimulus farmers made great efforts to increase production, and in spite of depleted supplies of labour they kept the country provided with food. Soon after the peace, however, there set in a severe break in prices due to the general financial dislocation. Unemployment was rife in all parts of the country and Poor Law methods added to, rather than mitigated, the difficulties. To make the resemblance between 1822 and 1922 even closer, there was a remarkable similarity in the seasons. The history of the years following 1822 affords hope for the future. Agriculture improved with the gradual readjustment in the financial and commercial position, while the introduction of railways proved of enormous benefit. From 1836 onwards progress was unmistakable, while the founding of Rothamsted in 1843 and of the Royal Agricultural College, Cirencester, in 1845 marked the introduction of scientific methods which completely revolutionised British agriculture and opened up an era of prosperity that closed only when the new countries of the West flooded our markets with produce at prices with which the British farmer could not compete. It is a hopeful augury for the future that the scientific organisation is already well developed. Colleges and new research stations have been opened, Rothamsted has been reorganised and greatly extended during the last few years, while Cirencester was reopened a few weeks ago.

It is difficult for any one who has received a scientific training to believe that anything can be said in favour of our cumbersome and complicated system of weights and measures, or to understand the difficulties which are advanced against the adoption of the metric system, which has become the international language of quantity. In his presidential address to the Decimal Association on November 23, Sir Richard Gregory pointed out that in forty-six countries of the world the system is now obligatory, the latest addition being Japan, which adopted metric measures in April last. The United States and the British Empire are the only two civilised nations which remain outside this circle, and they must come within it eventually, as there is no possibility of the Imperial system being adopted internationally. With every development of electrical science metric measures come into increasing use; for all the units employed are based upon the metric system. In wireless communication, and for broadcasting, wave-lengths are expressed in metres, and in aviation international regulations are similarly described. Even among English-speaking peoples there is much diversity in the weights and measures employed. The standard gallon in the United States is the old wine gallon of 231 cubic inches instead of the Imperial gallon of 277·274 cubic inches; the hundredweight there and in Canada is the cental of 100 lb. instead of the Imperial cwt. of 112 lb.; and the ton is the short ton of 20 centals or 2000 lb. instead of the ton of 2240 lb. The simplest way to avoid the confusion consequent upon these and other diversities would be to adopt the metric system, and the Decimal Association and American Metric Association working for this end may be assured that their efforts must finally achieve success.

In order to demonstrate some of the minor uses of home-grown timber a special exhibit is on view in Museum iv, in the Royal Botanic Gardens, Kew, of requisites commonly used in kitchen, laundry, and dairy. Among them are bread boards, rolling-pins, towel rollers, measures, scoops, bowls for milk and pastry, butter knives and pats, butter prints, dishes for skimming milk, potato mashers, steak beaters, brushes and brush backs, spoons, mangle rollers, a washing dolly, egg-cups, a plant-tub, and some wood wool. The last-named is a most useful substance for packing fruit, glass, and crockery. The principal woods used for these articles are beech, lime, sycamore, birch, elm, poplar, and willow. A number of articles are shown in various stages of manufacture, thereby demonstrating the immense amount of work that is required to produce a common utensil that may be purchased for a few pence, and at the same time indicating what an important part is played by the manufacture of home-grown timber, even into minor articles, in the provision of employment for large numbers of men and women.

Some interesting figures are given in the issue of the *Engineer* for November 17, which show the relative costs of transport by different agencies working at their normal speeds. The list opens with the barge, with a speed of 1 mile per hour at an estimated cost of 0·0004*l*. or $\frac{1}{10}$*d*. per ton-mile, and at the other extreme is the maximum expenditure per ton-mile of the R.A.F. in England, with the cost for a speed of 100 miles per hour of 9·3*l*. or 2232*d*. Between these extremes are some surprising results, some of which are based on official figures while others are estimates. The London motor omnibus at 10 miles per hour costs 0·016*l*. or 4*d*. per ton-mile. An electric passenger train (3rd class) at 25 miles per hour costs 0·018*l*. or 4*d*. per ton-mile, while the corresponding steam train at 40 miles per hour costs 0·024*l*. or 6*d*. With these figures can be considered the cost per ton-mile at 12 miles per hour of a liner (1st class), which is 0·22*l*. or 53*d*., though for the liner (3rd class), it is only 0·1*l*. or 24*d*. The London-Paris passenger aeroplane service, assumed to travel at 100 miles per hour, at present rates costs 0·33*l*. or 80*d*. per ton-mile, though the estimate of the Advisory Board for Civil Aviation is 0·7*l*. or 168*d*. The cost of running a Rolls-Royce car, assuming a speed of 22 miles per hour, is estimated, at the maximum, to be 1·0*l*. or 240*d*. per ton-mile. Turning now to carrying services, it is interesting to find that parcel post, for a speed of 12 miles per hour, costs 0·07*l*. or 17*d*. per ton-mile, while letters, at 17 miles per hour, cost 0·55*l*. or 132*d*. per ton-mile, and the postman himself, travelling at 3 miles per hour, is estimated to cost 4·85*l*. or 1164*d*. per ton-mile. Estimates for the rigid airship vary from 0·016*l*. or 4*d*. per ton-mile at 80 miles per hour to 1·8*l*. or 432*d*. per ton-mile at 40 miles per hour, the latter figures referring to a machine assumed to carry a load of 10 tons.

THE issue of *Science* for November 3 contains a paper by Dr. J. R. Schramm of the National Research Council on "The Abstracting and Indexing of Biological Literature," which is of interest as it shows that in the United States the subject of the organisation of bibliography is entering the field of practical politics. Dr. Schramm's paper is eminently businesslike. He first investigates the wants of the research student and decides in favour of sufficient abstracts published in book-form, with adequate indexes—"the complete subject index being perhaps of the greater importance." He then turns to the publishing aspect and points out that with adequate support in the shape of a guaranteed circulation, the cost of composition is a relatively small matter—each copy costing little more than the cost of paper, machining, binding, and distribution. From these data he goes on to advocate publication on the lines of *Chemical Abstracts*. The federation of the Biological Research Associations of the United States is, of course, a necessary preliminary, but here the first steps have already been taken under the ægis of the National Research Council. A committee has been formed to draft a constitution and to report on the whole question. Dr. Schramm does not underrate the difficulties before him, but we think that he underestimates the volume of literature with which the federated body will have to deal. If the statistics of the International Catalogue of Scientific Literature afford any guide, the federation will have to deal with an output at least double that of pure and applied chemistry. The order for the output of the International Catalogue for 1901–13 was (1) physiology, (2) zoology, (3) chemistry, (4) botany, (5) bacteriology. It is, however, premature to discuss a scheme which has not yet been definitely forwarded. We shall be content to express a hope that we may be favoured with a copy of any further report of the committee's activities.

THE Iron and Steel Institute, 28 Victoria Street, S.W.1, is prepared to receive before the end of February next, upon a special form obtainable from the secretary, applications for grants from the Andrew Carnegie Research Fund in aid of research work on the metallurgy of iron and steel.

CAPT. H. RIALL SANKEY will deliver his presidential address to the Junior Institution of Engineers on Tuesday, December 12, at 7.30, taking as his subject "The Utility of Theory to the Practical Man." The address will be given at the Royal United Service Institution, Whitehall.

A COURSE of twelve free public Swiney lectures on "Fossils and what they teach" will be given in the lecture theatre of the Imperial College of Science and Technology, South Kensington, by Prof. T. J. Jehu at 5.30 on Tuesdays, Thursdays, and Fridays, beginning on Tuesday, December 12.

THE gold medal of the Ramsay Memorial Fund, which the Prince of Wales would have received after unveiling the memorial in Westminster Abbey if he had been able to be present, was presented to him on November 22 by the French Ambassador, the Comte de Saint-Aulaire, who was accompanied by the officers of the memorial fund.

IN connexion with the Institute of Industrial Administration a lecture on "Standardisation of Repairs in Relation to Industrial Economy" will be delivered at the London School of Economics, Houghton Street, Aldwych, on Tuesday, December 12, at 8 o'clock, by Mr. R. Twelvetrees. The meeting will be open to all, and the lecture will be followed by a discussion.

THE council of the Institution of Electrical Engineers of London at the last meeting announced that Dr. J. A. Fleming had been elected an honorary member of the Institution. Dr. Fleming has accepted the invitation to give the fourteenth Kelvin lecture to the Institution in May next. The Royal Society of Arts recently awarded Dr. Fleming a silver medal for the fifth Henry Trueman Wood lecture he delivered on November 23, 1921, "On the Coming of Age of Long-Distance Wireless Telegraphy and some of its Scientific Problems."

THE Committee of the Norfolk Agricultural Station, Norwich, will shortly appoint a director and solicits applications for the post, which will be of the annual value of 600*l*., plus travelling and incidental expenses. In the first instance the appointment will be for one year only. Applicants must possess a modern scientific training in agriculture, with university degree or diploma, practical knowledge of mixed farming, organising ability, and be qualified to lecture. Applications, with testimonials, must reach the honorary secretary of the committee, 32 Prince of Wales Road, Norwich, by, at latest, Saturday, December 9.

THE first country meeting of the Association of Economic Biologists since pre-war days will be held in the Botanical Department of the University of Manchester on Friday, December 15, when Dr. W. Lawrence Balls will open a discussion on "Genetics in Relation to Applied Biology." Dr. S. G. Paine will read a paper on "Internal Rust Spot (Sprain and Net Necrosis) in the Potato and the Possible Association of this Disease with Leaf Roll," followed by informal discussions on "The Place of Applied Biology in Universities," and "The Relation of Biology to Medicine." On Saturday, December 16, a visit will be paid to the British Cotton Industry Research Association, Shirley Institute, Didsbury.

THE suggestion made by Mr. F. Gill, president of the Institution of Electrical Engineers, in his recent address, that an international European conference should be held with the view of establishing on a commercial basis a practical system of long-distance telephony in the European trunk lines, has now been realised by M. Paul Laffont, the French Minister of Telegraphs and Telephones. He proposes to invite a conference at Paris of the technical administrators of the Western European countries, and he urges that France would naturally be the centre of the vast telephone system formed by combining the systems of these countries. The long-distance

telephone calls in daily use in America show that, from an engineering point of view, the scheme presents few difficulties. Thus the New York-San Francisco call (3000 miles) is equivalent to communication between London and Baghdad; the Key West (Florida) and Los Angeles call *via* New York and San Francisco is equivalent to a London-Delhi communication. English engineers all welcome the conference, as they have good hopes of arriving at a satisfactory international agreement.

THE *Quarterly Summary* of the Royal Botanic Society, Regent's Park, for October contains a list of some of the recent interesting accessions to the gardens, and a short account of the experimental work in genetics being carried out there. Another item of interest is an account of the Indian Mahwa tree, *Bassia latifolia*, a member of the Sapotaceæ, the flowers of which have the remarkable property of showing no deterioration even after being stored for a year or two in England, nor are they attacked by moulds. They contain quantities of sugar and have been suggested as a source of alcohol, but their peculiar preservative powers have apparently not been investigated.

A NOTEWORTHY departure was taken at the meeting of the Royal Institute of British Architects on November 20, when a paper on "Illuminating Engineering in Relation to the Architect" was read by Mr. L. M. Tye. A vote of thanks to the lecturer was proposed by Sir John Herbert Parsons, president of the Illuminating Engineering Society, who referred to the good results that had followed from the co-operation of the medical profession and the lighting expert in dealing with the effects of light on the eye, and expressed the conviction that similar benefit would be derived from the concerted efforts of architects and illuminating engineers. Mr. L. Gaster suggested that courses of instruction on artificial lighting should be included in the curriculum of architectural students, and Mr. Paul Waterhouse, who presided, received these suggestions with sympathy. There is no doubt that the lighting of many public buildings, schools, etc., would gain by closer co-operation of this description, and the Illuminating Engineering Society should do good public service by its efforts to enlist this new ally in its campaign for more scientific methods of lighting.

THE opening meeting of the session of the Illuminating Engineering Society took place on November 14, when Mr. L. Gaster read the usual report of progress during the vacation. An event of outstanding importance has been the third Report of the Home Office Departmental Committee on Lighting in Factories and Workshops. Mr. Gaster directed attention to an important "access of light and air" judgment in Bradford, which illustrated the importance now attached to scientific measurements of daylight illumination in such cases. It was mentioned that a commission on illuminating engineering has now been formed by the Central Electrotechnical Council in Russia. In accordance with custom, there were a series of exhibits illustrating developments in lighting. A new and simple illumination photometer was exhibited by Capt. Stroud, and an improved form of inspection lamp for use in hospitals by Mr. Hobson. Mr. S. O. Pearson demonstrated an interesting "blinking" phenomenon when neon lamps are shunted by a condenser on direct-current circuits, and Capt. W. J. Liberty presented some photographs showing the artificial lighting arrangements at the new Port of London building. Some novel forms of illuminated signs, based on total internal reflection in a sheet of plate glass, were exhibited by Mr. E. T. Ruthven Murray.

AT the Royal Academy, on November 22, Prof. A. P. Laurie, in a lecture on "The Preservation from Decay of Stone on Buildings," dealt with the general causes of stone decay. He showed by experiments the distinctions to be made between limestone, sandstone with a calcite cement, and sandstone with a silica cement, and described the different methods necessary to make complete laboratory tests with a suggested preservative, and illustrated by photographs some of the difficult problems which have to be faced. Prof. Laurie described a new preparation recently discovered by him, which deposits hydrated silica as a cement between the particles of the stone, and he stated that, while not solving the problem of the preservation of limestones, he hoped that it would prove successful in the preservation of sandstones. He further suggested that the Royal Institute of British Architects might find it worth while to experiment with this new preservative.

THE annual Progress Report of the Geological Survey of Western Australia for the year 1921 contains a useful summary of economic minerals known to exist in that State. Among these are, in the first place, gold, then copper ores, lead ores, tin ores, iron ores, and manganese ores, together with a number of rarer minerals such as wolfram, scheelite, stibnite, barytes, monazite, tantalite, glauconite, salt, gypsum, etc.; coal of different geological ages is known, although only permo-carboniferous coal has been worked to any extent.

SOME papers of much interest to marine biologists are contained in the recently issued number of the Journal of the Marine Biological Association (vol. xii. No. 4, October 1922). Mr. R. S. Clark gives descriptions, illustrated by beautiful photographs, of the egg capsules and young of various species of rays and skates. This work was badly wanted. Miss Lebour and Mr. Andrew Scott write on the food organisms of young edible fishes, and Miss Lebour and Mr. R. Elmhirst make a very useful contribution to parasitology in the form of an account of the life-history of *Parorchis acanthus*, a trematode inhabiting the herring gull.

IN further reference to the obituary notice of Dr. Alexander Graham Bell in NATURE of August 12, p. 225, Mr. F. De Land, of the Hubbard Memorial Hall, Washington, writes, giving us quotations from English papers of 1877, of telephone transmission over distances greater than 100 miles. He also gives a quotation from our own columns (November 15, 1877,

vol. 17, p. 49) of a report of a lecture by Graham Bell, stating that on one occasion the lecturer had been able to converse over a distance of about 250 miles. Our reference, however, in the obituary notice of Graham Bell, was to *commercial* telephony. In the Journal of the Institution of Electrical Engineers, April 1922, p. 429, Mr. Kingsbury gives the following quotation from the first business circular issued by Graham Bell and his associates. They state that they were "prepared to furnish telephones for the transmission of articulate speech through instruments not more than 20 miles apart."

PROF. H. E. ARMSTRONG asks us to say that in his letter published in NATURE of November 25, p. 700, he wrote Babelonian, which was altered without his approval to Babylonian—thus obliterating his point.

AMONG the books to be published by the Cambridge University Press during December is "Prolegomena to Analytical Geometry in Anisotropic Euclidean Space of three Dimensions," by E. H. Neville, the first half of which will be an account of the principles underlying the use of Cartesian axes and vector frames in ordinary space. The second half will describe ideal complex Euclidean space of three dimensions and develop a system of definitions in consequence of which the geometry of this space has the same vocabulary as elementary geometry, and enunciations and proofs of propositions in elementary geometry remain so far as possible significant and valid. The same publishers also promise for this month "A Summer in Greenland," by Prof. A. C. Seward. It will contain some 30 maps and illustrations.

Our Astronomical Column.

POSSIBLE RECURRENCE OF A METEOR SHOWER.—On the morning of December 5, 1921, there was observed a very rich shower of meteors from Leo Minor at 156° +37°. The event was witnessed at the Astronomical Observatory at Tokyo by the observers there, who recorded 44 meteors in 55 minutes, radiating from the special shower alluded to. The position in the N. part of Leo Minor from which the meteors were directed has been known for many years as the centre of a rich shower of swift, streaking meteors in October, November, and the first half of December. It was well observed at Bristol in 1876, November 20-28, from the point 155° +36° (21 meteors), and is especially described as a possibly new and very active shower in NATURE for December 21, 1876, p. 158. Should this meteoric display recur in the present year it may be looked for in England at about midnight and the two hours immediately following, on December 4. The moon will, however, be nearly full and will moderate the character of the display. It will certainly be important to observe it if possible, and it is hoped that the sky will be attentively watched on the date in question.

CALENDAR REFORM.—Mr. Charles F. Marion, of the U.S. Weather Bureau, has published a leaflet strongly urging the adoption of a 13-month calendar, each month to consist of 4 weeks exactly. One day in the year, preferably the last, would be outside week and month. In leap-year there would be another such day, which might conveniently precede the first day of the seventh month. The names "Sol" or "Midyear" are suggested for the seventh month, the other months having their names unchanged. It is pointed out that meteorology would be greatly simplified by such a system, since records at present are complicated by the unequal months. Further, since each particular week would then always occupy the same place in the solar year, monthly records could be supplemented by weekly ones.

The chief objection brought against the 13-month year is that it does not divide into quarters. But it is to be noted that the existing quarter-days are not at the ends of months. To place them after the first week of the fourth month, the second of the seventh month, etc., would be very little more complicated than the present system. Monthly payments would be made 13 times per annum instead of 12, and the anomaly of paying the same for 28 days as for 31 would be removed.

Astronomers would welcome the equalisation of the months and the removal of leap-day from its present awkward position. The year 1928 begins with a Sunday, so the change might then be made with a minimum of dislocation.

A bill has been introduced into the United States Congress authorising and requesting the President to call an international conference on the subject in 1923. It is suggested that the dates of religious festivals are best left to the religious bodies to determine: it introduces needless difficulties to superpose these questions upon changes in the civil calendar.

THE BRIGHTNESS AND ROTATION OF URANUS.—*Astr. Nachr.* No. 5184 contains a paper on this subject by C. Wirtz. He has made a very careful series of magnitude determinations with a Zeiss field-glass from July 1921 to January 1922. The mean magnitude, reduced to mean opposition, is 5·64. The magnitudes of the six comparison stars were taken from Harvard; small corrections, leaving the mean magnitude unchanged, were deduced from his own observations. The author is evidently a skilled observer and the probable error of each night comes out as $0{\cdot}04^m$, that of the mean being less than $0{\cdot}01^m$. He has grouped them in accordance with the rotation period of $10\frac{3}{4}$ hours given by the spectroscope, and finds a sine-curve with an amplitude of $0{\cdot}02^m$, which he regards as too small to receive with confidence; in 1917, L. Campbell found a curve with an amplitude of $0{\cdot}15^m$, but if the physical state of Uranus is like that of Jupiter, changing spots might well alter the amplitude.

Wirtz suggests that it is worth while to keep up the investigation of the magnitude of Uranus from year to year, as it may throw light on the oblateness of the disc. He estimates that when the pole is near the centre, the magnitude should be about $0{\cdot}1^m$ brighter than when it is on the edge; this is an amount within the reach of delicate photometry. He thinks, however, that the apsidal motion of the inner satellite Ariel should give a more trustworthy value.

MISCONCEPTIONS ABOUT RELATIVITY.—Since the verification of the Einstein bending of light by gravitation in 1919, many speculations on the subject have appeared in astronomical publications. A letter in the Journal of the R.A.S. of Canada (September–October 1922) suggests that the Gegenschein is the result of the bending of sunlight by the earth's attraction so as to come to a focus. The amount of bending of a grazing ray is proportional to mass/radius, so that the bending at the earth's surface is $1''{\cdot}75/3000$ or 1/1900 of a second of arc. It is manifest that such an infinitesimal bending could produce no discernible optical effects, and it seems inadvisable to print such suggestions without comment, since their appearance in such a weighty journal is calculated to mislead.

Research Items.

SOME ROMAN ANTIQUITIES.—Two articles in the *Journal of Roman Studies* (Part 1, vol. 10 for 1920) refer to antiquities in England. In the first, Mr. A. M. Woodward describes a decorative bronze Silenus mask found at Ilkley during excavations conducted by the Yorkshire Archæological Society. This was probably used as a jug-handle, and that a bronze vessel so elaborate should be found at the quarters of an auxiliary cohort is at first surprising. But the site seems to have been long occupied, and the inhabitants included a civilian settlement. The vicinity of York, a great military station, may have led to the introduction of articles of luxury. In the second paper Mr. C. D. Chambers remarks that, although the Romans valued pigeon manure, it is strange that so few dovecots of that period have been discovered. Though octagonal foundations like those of medieval dovecots have been found at Great Witcombe and Stroud, rectangular dovecots, though probably numerous, cannot be identified with certainty, except where the pigeon-holes actually exist, as at Caerwent. If excavators were to look for dovecots rather than shrines, it is not unlikely that further evidence would be forthcoming.

THE PITUITARY BODY.—A paper by Bailey and Bremer ("Experimental Diabetes Insipidus," "Archives of Internal Medicine," vol. 28, p. 773) serves as a timely warning against hasty conclusions of the existence of internal secretions when the results have been brought about by injury or disease supposed to be limited to a particular organ. There are three symptoms supposed to be produced by injury of the pituitary body—increased urinary secretion, hypertrophy of fatty tissue, and atrophy of the testis. Camus and Roussy had already brought evidence that these effects were due to injury of that part of the brain, the hypothalamic region, in close contact with the pituitary body, but they do not appear to have been altogether successful in avoiding some injury to the latter also. The work of Bailey and Bremer was done in the laboratory of Prof. Harvey Cushing, and the pituitary region was reached by a slight modification of the operation described by Crowe, Cushing, and Homans. The pituitary body itself and the neighbouring parts of the brain can be clearly seen, and it was found that a small injury to the hypothalamus, leaving the pituitary completely intact, was sufficient to bring about the three symptoms above mentioned, which are supposed to be due to injury to the pituitary body itself.

STERILITY IN SPECIES-CROSSES.—Results have been accumulating for a number of years, showing that in species-crosses in various animals one sex is either absent, rare, or sterile. Such disturbances of the sex-ratio, or sterility of one sex in the hybrids, have been observed by Tutt, Harrison, Goldschmidt, and others in Lepidoptera, by Whitman, Riddle, and others in birds, by Sturtevant in Drosophila. Among mammals, guinea-pigs and Bovidæ show similar distortions of the sex-ratios. Mr. J. B. S. Haldane, in an interesting review of all these and similar results (*Journ. of Genetics*, vol. 12, No. 2), shows that in every case it is the heterozygous sex which is deficient in numbers or sterile in such species-crosses. Thus in mammals and flies this applies to the male sex, which is the heterozygous sex, while in birds and butterflies it applies to the female sex, which is known from breeding experiments and cytological study to be the heterozygous sex in these groups.

CHROMOSOMES OF THE "MILLIONS" FISH.—In two papers on the cytology and genetics of the little "millions" fish, Lebistes, Dr. Ö. Winge (*Journ. of Genetics*, vol. 12, No. 2) finds the number of chromosomes to be 46 in both sexes, and concludes that the males must therefore have an XY pair of sex-chromosomes. In extending the breeding experiments of Dr. J. Schmidt, who showed that certain colour markings of the males are inherited only from male to male (hence through the Y-chromosome), he finds four such colour-marking factors in the Y-chromosome of different races of this fish. In addition, Dr. Winge makes the interesting discovery that in the "Magdeburg race" the X-chromosome contains a factor which gives a sulphur-yellow colour to various parts of the body and a red colour to the lower margin of the caudal fin. This factor is inherited in the usual fashion of sex-linked factors, except that all these characters are invisible in the females. Some evidence is also obtained of crossing-over between these factors in the X- and Y-chromosomes. This, if confirmed, will furnish an interesting extension of our knowledge of sex-linked inheritance. When colour-marking factors are present in the X- and Y-chromosomes of a male they both show in its visible pattern, but one is transmitted, like the X-chromosome, through the daughters to their sons, while the other is transmitted (in the Y-chromosome) directly from father to son.

COTTON RESEARCH IN EGYPT.—The second annual report, for 1921, of the Cotton Research Board, issued by the Egyptian Ministry of Agriculture, indicates clearly that the improvement of the cotton crop, with which the prosperity of Egypt is so closely connected, is being seriously dealt with by methods of research. The Board has given special consideration, among other matters, to the decline in yield, two-year *v.* three-year rotations, and control of seed used for sowing. A summer fallow appears to be of great value in maintaining the fertility of the soil, as the temperature of the surface soil rises sufficiently high to have a partial sterilisation effect by suppressing the harmful factor which has been shown to exist in Egyptian soils. The value of Nile silt as a fertiliser seems hitherto to have been exaggerated. Yield may not be much affected by reduced watering, but quality may be adversely influenced. Work is being done on the extraction of pure lines, propagation of selected strains and field tests of commercial varieties, in order that types may be selected that shall be most suitable for the purpose required. Special efforts have been made to find a method of controlling the sore-shin disease, the usual means being ineffective or impossible of application on a large scale. Various reagents have been used for soaking the seeds, and the effect of sowing on different dates has been tested, but no conclusive results are yet available. Insect pests are also receiving attention, pink boll-worm and cotton-seed bug being under investigation.

THE CRANIAL MORPHOLOGY OF FISHES.—Two important papers on the anatomy and morphology of fishes appear in the *Journal of Anatomy* (vol. 56, Pts. 3 and 4). In the first of these Mr. E. Phelps Allis, junior, describes in great detail the cranial anatomy of Polypterus, illustrated by twenty-two beautifully executed plates, all except two of which are in colour. In the second paper Dr. H. Leighton Kesteven strongly criticises Huxley's interpretation of the bones in the palate and upper jaw of bony fishes and offers a new concept of their significance and homologies. He regards the premaxillæ and maxillæ of the majority of teleostean fishes as constituting

an adventitious jaw which is homologous, not with the similarly named bones in other vertebrates, but with the labial cartilages well developed in most Elasmobranchs, present in Polypterus and evanescent in the Amphibia. The vomer, anterior portion of the parasphenoid and palatine of the teleostean skull are regarded as homologous respectively with the premaxillæ, vomer, and maxilla of other vertebrates. This new interpretation of the upper jaw of the teleostean fishes necessitates changes in the concept of the homologies of other bones in the palate of these fishes, which the author states briefly and analyses in detail. The quadrate bone of teleosteans is the only bone which the author regards as correctly homologised.

JAPANESE GEOLOGY.—The National Research Council of Japan has instituted a *Japanese Journal of Geology and Geography*, of which the second number lies before us. In addition to various abstracts it contains two original papers. The first, by Prof. I. Hayasaka, treats of "Some Permian Brachiopods from the Kitakami Mountains." Only six species are described, none being new to science, but there is a promise of more when the additional material shall have been worked out. The second paper is on "Uhligina, a New Type of Foraminifera found in the Eocene of Japan and West Galicia," by Prof. H. Yabe and S. Hanzawa. The authors consider this new form to be a close ally of the Carpathian species *Rupertia incrassata*, Uhlig, and since both differ in important characters from Rupertia, the new genus Uhligina, having as genotype *U. boninensis*, n.sp., from the Middle Eocene nummulitic tuff of Oki-mura, is established for their reception.

WIND VELOCITY AND DIURNAL RANGE OF TEMPERATURE.—A discussion on diurnal variation of temperature as affected by wind velocity and cloudiness, Professional Notes, No. 30, has just been issued by the Meteorological Office of the Air Ministry. The observations from the Eiffel Tower have been used in conjunction with those at Parc St. Maur by Captain J. Durward. The object of the discussion is to get an idea of the magnitude of the rise and fall of temperature at different levels under different weather conditions. Observations are compared for the five months, May to September, and for the five years, 1905 to 1909. The respective heights above sea-level of the thermometers at the two stations are 335 metres and 50 metres, a difference of 285 metres or 935 feet. The lower station, Parc St. Maur, is 11·5 km. to the east-south-east of the centre of Paris. Among the principal results may be mentioned the temperature distribution on fair nights. When the radiation is unimpeded the layer of air in contact with the ground is cooled more quickly than the layers immediately above, and being cooled it tends to remain near the earth's surface. This leads to an inversion in the lower layers of the atmosphere, the magnitude depending on the wind velocity, as the layers not in immediate contact with the ground are cooled greatly by turbulence; the results are given in a table.

OIL-DRILLING IN GALICIA.—Mr. Albert Miller's recent paper read before the Institute of Petroleum Technologists dealt with the Canadian pole-tool system of drilling for oil, as almost exclusively employed in Galicia at the present time. Notwithstanding the increasing popularity of the rotary system in other oil-fields, this system has proved unsatisfactory in Galicia, where the formations to be penetrated frequently change with surprising rapidity within a small vertical distance; this necessitates a high degree of flexibility of drilling plant. The paper included details of the tackle in use, and the different types of drilling-bits and fishing-tools were discussed, particular stress being laid on the need for standardisation of tool joints, the lack of which had proved almost disastrous in the past. Some useful information was given in connexion with casing and with its recovery when "frozen" in a well; a somewhat novel method of overcoming such freezing is to insert tubing connected to the steam-line and thus heat the casing for twenty-four hours; by this expansion, with subsequent contraction on cooling, the casing can often be moved; this method is also applicable in cases where accumulations of paraffin wax are the cause of such freezing. Methods of production of oil in Galicia were also considered, and these included, besides flowing wells, both deep-well pumps and "swabbing." This last practice is specially useful in wells that have stopped flowing, and in deep wells having small diameter casings but producing from compact sandstone. The swab consists of a plunger fitted with a ball-valve which works up and down inside the casing barrel; rubber packing rings are employed, and thus the swab has a suction effect on the well; an average vacuum of eight pounds can be obtained with fast running on the upward journey of the swab, and in this way several tons of oil may be won which would otherwise be left in the reservoir.

ASPHALT.—The report on the asphalt and related bitumen industries in the United States for the year 1921 has just come to hand (Asphalt and Related Bitumens in 1921, United States Geol. Sur., Mineral Resources, Pt. II.). In that year the United States marketed close on 300,000 short tons of natural asphalt (including grahamite, gilsonite, wurtzilite, impsonite, and bitumenous rock). By far the larger quantity of asphaltic material, however, is manufactured from crude petroleum during the process of refining the oil, the basis of this material being the residue resulting from distillation. The material is of two distinct kinds, asphalt and flux, the former comprising all the solid and semi-solid products of less than 200 penetration. The flux is utilised for softening natural asphalt or the synthetic product, especially for roofing purposes; it also includes the so-called "road-oil" used for spraying on the surface of metalled roads. For paving it is produced as sheet asphalt, or as asphalt concrete, or as a cement or filling for road and pavement blocks; the roofing and water-proofing material is manufactured by saturating, coating, or cementing felt or suitable fabric; in the rubber industry it is employed in many cases where a durable binding or cement is required. In other directions asphalt finds considerable use in the manufacture of insulating materials, acid-resisting compounds, mastic, paint, and varnish. In the United States, both domestic and Mexican petroleum are used as sources of the manufactured asphalt, the latter rather more than the former; in 1921 more than 600,000 tons of asphaltic material were produced from domestic petroleum, this representing about two-thirds of the amount obtained from imported oil from Mexico. The report also makes brief mention of the importation of natural mineral waxes, such as ozokerite, into the United States (which during the year under review increased more than 100 per cent.), while the manufacture of ichthyol compounds from a Texas oil is a noteworthy development. Ichthyol (a sulphonated hydrocarbon largely used in medicine) has in the past been produced from treatment of a fossiliferous deposit in the Austrian Tyrol; its manufacture from natural petroleum constitutes a factor of more than mere commercial interest.

The Society of German Men of Science and Physicians.

Centenary Celebrations at Leipzig.

It is a hundred years since the Society of German Men of Science and Physicians held the first meeting, also in Leipzig, on September 18, 1822. Only eighty-seven meetings have taken place in this period, as in the years of great national calamities, such as war or epidemics, no meetings were held. Though the first meeting after the World-War, at Munich in 1920, was well attended, the society resolved to meet only every two years, so long as the present economic distress in Germany prevails.

Among the scientific workers who attended this year's meeting there were represented not only the great seats of learning of Germany and the German-speaking countries, but also most of the countries who had in former times sent their representatives to this meeting. The president was the distinguished Berlin physicist, Prof. Max Planck, Nobel prizeman in 1918 for physics. The committee included, among others, Prof. Palthauf, the great Vienna pathologist; von Dyck, the Munich mathematician; Profs. Gottlieb (Heidelberg), Willstätter (Munich), His and Bonhöffer (Berlin), Rinne (Leipzig); Privy Councillor Duisberg (Leverkusen). The arrangements for the meeting were carried out under the supervision of Prof. von Struempell and Prof. Wiener, both of Leipzig.

After the opening address by Prof. von Struempell, on September 18, in which he expressed his satisfaction at the great new tribute paid to German science, addresses were given by representatives of educational authorities, teaching institutions, and learned societies. Among the foreign representatives were: Prof. Becke (Vienna), Prof. Schlosser (Prague), Prof. Hagenbach (Basel), Prof. Sigrist (Bonn), Dr. Sven Hedin and Prof. Svante Arrhenius (Sweden), Prof. Goldschmidt (Christiania), and Prof. Bokay (Budapest). Congratulatory messages were also sent from Holland, Spain, U.S.A., and other countries.

After expressing his thanks for the addresses and messages Prof. Max Planck gave a survey of the development of German science during the past hundred years. Referring to the World-War, he said that one possession has not been lost by the German nation, namely, its national unity. The reconstruction of Germany's prosperity and the rebirth of German culture are not possible without German science. Many of the most important inventions which are used in modern industrial life, such as wireless telegraphy, the fixation of atmospheric nitrogen, the Röntgen rays, had been discovered in purely scientific laboratories. It is necessary to spread among all the nations of the world the conviction that the preservation and extension of purely scientific research in Germany is as necessary for the welfare and happiness of that country and the whole world as the development of industry and the production of raw materials. Scientific work is international in its nature, and therefore well fitted for creating and furthering mutual understanding and peaceful co-operation among the peoples of the world. The German men of science and physicians were ready to respond to frank and honest approaches made by foreign fellow-workers, but they would naturally not think of begging for admission where they were not wanted.

The subject of the first general address was the theory of relativity. Prof. Einstein himself had originally intended to be present, but he was prevented from appearing by his journey to the East. It may be mentioned that a protest against this subject, as not yet ripe for scientific discussion, had been lodged by a number of well-known men of science of Germany and other countries. The lecturer was Prof. von Laue (Berlin), and he stated that the questions with which the theory of relativity is concerned are as old as science and scientific research. The modern problem is whether it is possible to ascertain an absolute velocity of any moving body. The transmission of light and electricity through space, even in a vacuum, has led to the assumption of an æther. All experiments, however, which have been made in order to discover how great is the velocity of the earth with respect to the æther have failed. The special or restricted theory of relativity, which maintains that it is impossible to ascertain any absolute velocity, has therefore been generally accepted by physicists.

It is a different question with the much more complicated and difficult general theory of relativity of Einstein. This is concerned with the old problem of the force of gravitation. Here mathematical processes have to be introduced which no physicist had thought of applying before Einstein. Though this part of the relativity theory has not yet been established so as to exclude every possibility of doubt, it can be regarded as an extremely valuable stimulus to further research.

This lecture was followed by an address by Prof. Schlick (Kiel) on the philosophical importance of the theory of relativity. He stated that the theory, though originally devised only to explain physical phenomena, has a great philosophical importance. The philosophical tendencies of Einstein's thinking pointed to a kind of positivistic philosophy, a philosophy of pure experience which takes no account of so-called elements or substances, and regards as the ultimate facts of all happening the observed events themselves. We may say that the period of the separation of philosophy and science is ended and that they are beginning to approach each other again.

On September 19 the first subject treated was that of heredity, and Prof. Johannsen of Copenhagen gave a survey of the work done during the past century in this field. The conclusion he comes to is that no positive result has been obtained in regard to the great questions of the origin of species and their evolution. A destructive criticism, however, of the chief ideas of both Darwin and Lamarck has been achieved, and the belief in natural selection as well as in a gradual fixation by heredity of qualities obtained by adaptation has been thoroughly shaken. Prof. Meisenheimer of Leipzig showed the results of experiments in crossing flowers, insects, and guinea-pigs. He explained the various connecting links, the mixed types, and described cases of reversion. His conclusion is that the experiments are subject to many chance influences and not very certain. It has been impossible, so far, to carry out all the calculable experiments; in many cases it will be necessary to resort to statistics.

Great interest was aroused by the lecture of Dr. Lenz of the University of Munich, on heredity in the human race. In this field, he stated, no experiments are possible. The only materials available are comparative observation of animals and plants and vital and genealogical statistics. The validity of Mendel's law has also been proved in the case of man; further, it is certain that no acquired qualities are inherited. In regard to the determination of the sex of unborn children, Dr. Lenz said that we can to-day already predict with a great degree of accuracy

the inherited qualities of children. There is no spontaneous degeneration and no ageing of a race, though the transmitted substance may be damaged by such poisons as alcohol and tobacco. Race-suicide among the educated classes is threatening the continuance of our civilisation. In order to lead to practical results in improving the race, racial biology must be supported by the State.

A very interesting series of lectures was given on the action of electrolytes on the organism. The first of these, entitled "Colloids and Ions," was delivered by Prof. Wo. Ostwald of Leipzig, and it provided the starting-point for a number of addresses. Prof. Hoeber, Kiel, dealt with the effect of the ions on physiological surfaces. We know to-day that no organ of the human or animal body, no plant, and no micro-organism reacts normally if the ions in the neighbourhood of the cells are not present in the proper proportions. The heart beats abnormally if it is surrounded by a minute excess of potassium ions or calcium ions. The corpuscles of the blood, in the same circumstances, may perish prematurely, or in the plant, growth may be abnormal. The ions are carriers of electric charges and they are active in all processes of stimulation of living tissues by means of electric currents. Their movements are also the cause of the curious electric currents which all living beings are capable of producing, and which represent the highest degree of excitement. The explanation of the nature of the effect of the ions is of the greatest importance for the proper understanding of the phenomena of life.

It is a curious fact that the ions need not penetrate into the living cells themselves. The conclusion is that they react with the surfaces of the cells, the "physiological boundaries." Three groups of phenomena were discussed. In the first instance, the cells themselves carry electric charges, and they interact with the charges of the ions. A result of this may be clotting, or "agglutination," as, for example, in the well-known case of the clotting of the blood-corpuscles during pregnancy. Secondly, the interaction of the salt-ions and the cell-surfaces produces the bio-electric currents which have been referred to above. In a model the substance of the cell-surfaces may be replaced by organic oils, and by bringing these oil films in contact with various salts the electro-physiological phenomena may be well imitated. Thirdly, a change in the composition of the normal mixture of ions on the surface of the cells alters the power of transmission of the surface, so that the normal diffusion between the inside of the cell and the surrounding fluid is disturbed. These results show that medical science will have to study these purely physico-chemical phenomena in order to be able to explain fully and deal properly with the processes of life.

Prof. Spiro of Basel, in dealing with the same subject, stated that every electrolyte seems to play a special part in the organism. Especially the effect of the small ions of water and of the colloid electrolytes must be studied. For health there must be a proper equilibrium of all the necessary ions.

Quite a sensation was caused by the lecture of Prof. Mayer of Hamburg on the new preparation against trypanosome diseases, "Bayer 205," produced and manufactured by Friedrich Bayer, Leverkusen (near Cologne). This new drug, which is said to contain neither arsenic, antimony, mercury, nor any other inorganic therapeutic reagents, has been extensively tested, both in Europe and tropical countries, and found to give excellent results in advanced stages of sleeping-sickness and other trypanosome diseases. A station for further experiments has been fitted up in South Africa.

In the geographical section Dr. Sven Hedin lectured on his travels in Tibet, summarising the results contained in his various works and producing a great number of fine lantern-slides. The lecture was enthusiastically received.

A great number of papers was read by eminent medical workers on special subjects. Prof. Flechsig gave a survey of his well-known studies in mental pathology in a lecture on the localisation of the brain functions. Many lectures were also delivered on technical and industrial subjects, such as workshop control by means of optical measuring instruments and modern methods of rapid reception and despatch of wireless messages.

The two lectures on enzymes, by Profs. Willstätter of Munich and von Euler of Stockholm, were well attended and full of interest. Prof. C. Neuberg of Berlin lectured on recent advances in the study of fermentation.

A special feature of the congress was the lecture by Prof. Wilhelm Ostwald of Leipzig on his new methods of quantitative determination of colours. Based on the Law of Fechner, his system of colours includes the dull colours which Helmholtz excluded. The colours of our environment cannot be measured by wave-lengths, but only by means of revolving coloured discs with a variable black sector. New was the communication that we nowadays no longer distinguish six principal colours, but must assume eight, which number agrees with Fechner's Law.

Space forbids more than a short reference to the valuable lecture by Prof. Svante Arrhenius of Stockholm on physical law in the cosmico-chemical processes, by Prof. V. M. Goldschmidt of Christiania on the metabolism of the earth, and by Prof. Nernst of Berlin on photo-chemical processes. In the last of these it was stated that Einstein's law of photochemical equivalents no longer holds good. Light does not produce a primary splitting up of the chemical substance, but an addition of energy. Our photographic plates would have to be 6000 times more sensitive in order to approach to the ideal.

Many more valuable lectures on special subjects were delivered. The town of Leipzig showed its splendid hospitality and provided entertainments and many occasions for social and personal intercourse.

B. RASSOW.

The Present Position of Darwinism.

ONE of the discussions which aroused most interest during the British Association meeting at Hull was that held jointly by the botanical and zoological sections on "The present position of Darwinism." There was a large attendance, the discussion being presided over by Prof. H. H. Dixon, who was supported by Dr. E. J. Allen. The theory of the origin of species by natural selection, which has already been assailed by the geneticists, was attacked from a different point of view by Dr. J. C. Willis and Mr. Udny Yule, who treated the subject with special reference to geographical distribution and the statistical analysis of genera and species. During the discussion the older view as to the significance of natural selection was stoutly maintained by some speakers.

After a few introductory remarks by Prof. Dixon, the discussion was opened by Dr. J. C. Willis, who

spoke of "The inadequacy of the theory of natural selection as an explanation of the facts of geographical distribution and evolution." Dr. Willis pointed out that Darwin's immortal service to science consisted in the firm establishment of the doctrine of evolution. This was effected by devising the mechanism of the natural selection of infinitesimal variations, the principle usually known under the name of Darwinism. This theory involves many assumptions: among others, that such variations are (1) continuous, (2) hereditary, (3) differentiating, (4) selected, and (5) that the necessary differentiating variations for the associated characters appear together. For all of these the proof is as yet insufficient.

Dr. Willis proceeded to consider the extent to which natural selection of small variations could be held to explain the facts of geographical distribution, morphology, and evolution, special reference being made to the grasses and to the Chrysomelid beetles. It was then pointed out that natural selection was helpless to explain the differences in distribution of closely related species, which, on the other hand, could be explained on the hypothesis of "Age and Area"—*i.e.* that the area occupied by any group of allied species (at least ten) depends chiefly upon the ages of the species. On this hypothesis predictions could be made which were found to be justified by facts. Dispersal of species is held to be mainly mechanical: so much dispersal in so much time. This suggested the further hypothesis of "Size and Space"; that, in groups of ten allied genera, the total space occupied goes with the total number of species. If this be true, whatever phenomena are shown by "Area" should also be shown by "Size." This in fact is shown to be the case when the number of allied species occupying areas of increasing size and the number of species in allied genera are plotted in the form of curves. The shape of the curves is invariably uniform. But sizes of genera are clearly the result of evolution. According to the theory of natural selection, the sizes of genera must depend upon their success, and it is, therefore, inconceivable that they should show such uniformity of expression. Such facts, however, are easily explained by the hypothesis that geographical distribution and evolution extend with age—*i.e.* that the factors causing them act at a more or less uniform rate. Natural selection, which is essentially differentiating, cannot explain these facts.

In consequence, however useful it may be to explain details of certain adaptations, and although everything at birth must pass through the sieve of natural selection, it seems that the latter principle must be abandoned as an important factor in geographical distribution and evolution. Finally, Dr. Willis considered it necessary to accept large mutations as being of greatest importance in evolution. In his opinion Guppy's theory of differentiation should replace the Darwinian position that evolution has proceeded from individual through variety to species, genus, etc., for the theory of "Age and Area" showed clearly that the family is older than the genus, and that the genus is older than the species.

Mr. G. Udny Yule spoke upon "A mathematical conception of evolution based on the theory of Age, Size, and Space." He suggested that if the size of the genus be considered an index of its age, species might be regarded as thrown by the genus much as offspring are thrown by a stock, and that the number of species originating from a given initial species will increase in geometric ratio with the time. The forms of frequency distribution for numbers of genera with numbers of species were shown to be in accordance with the facts, and the possibility was suggested of determining from such distributions the ratio between the rates of increase of genera and species and the age of the family in terms of the doubling period for species.

Mr. C. Tate Regan stated that in his special study of fishes he had formed conclusions as to the origin and relationships of species and genera which were quite different from those of Dr. Willis. He pointed out that the hollow curves of the previous speakers were extreme types of asymmetrical curves which could also be obtained from many sorts of data—*e.g.* by plotting graphically the wealth of the community, grading from many poor to few very rich, or from the numbers of occurrences of surnames in the London Telephone Directory. All these curves were simply graphic representations of certain facts the meaning of which could be ascertained only by detailed analysis. According to his own view, the first step in the origin of a species had been not a change of structure but some form of isolation. The extreme mutationists, who thought that adaptations originated as large transformations without relation to use or environment, seemed to have returned to the special creation theory. Darwin's theory of evolution was that species had been modified by the natural selection of slight variations, aided by the inherited effects of use and disuse, and, in an unimportant manner (so far as adaptations were concerned) by the direct action of the environment. That theory was put forward by a man who knew the facts to be explained. Mr. Tate Regan claimed that Darwin's theory explained them and that no other theory stood the test.

Prof. W. Johannsen spoke from the point of view of a geneticist. He pointed out that selection could not produce anything, but it should be borne in mind that Darwin's belief in a productive power of selection was fully logical from the naive view of his time. The mutations which we knew did not explain the nature of evolution or the origin of large differences such as the differences between families. Modern genetics could scarcely contribute to a solution of the main problems of evolution, but it seemed to have cleared the ground from the erroneous Lamarckian and Darwinian views. He himself and, he thought, most geneticists were agnostics as to the mechanism of evolution.

Mr. J. T. Cunningham thought that natural selection was "as extinct as the dodo," and that the origin of species was due to mutations. Specific characters were for the most part useless, but other groups might be distinguished by adaptive and non-adaptive characters. He discussed adaptation, which he considered to have arisen in a Lamarckian manner. Modern discoveries concerning internal secretions showed how many adaptations exhibiting recapitulation might have been produced by stimuli and functional exercise.

Dr. H. Wager urged that there was more in the theory of natural selection than was implied by Dr. Willis and Mr. Cunningham. Fluctuating variations were dismissed from having evolutionary significance, but mutations were not necessarily large. He reminded the audience that an alternative title given by Darwin to "The Origin of Species by means of Natural Selection" was "The preservation of favoured races in the struggle for life," which might be interpreted in modern terms as "The preservation of favourable mutations."

Prof. E. B. Poulton discussed the theory of "Age and Area" in relation to mimicry, and pointed out that in certain African butterflies the younger form is distributed over a much wider area than the ancestral type.

Dr. Chalmers Mitchell supported Mr. Tate Regan, and considered that Dr. Willis had presented merely

a caricature of natural selection. He appealed for the study of individual life forms.

Prof. A. C. Seward considered that the great uniformity of the curves presented by Dr. Willis and Mr. Udny Yule was suspicious, for Nature had not been uniform. He pointed out that, as regards conifers and ferns, study showed that the forms existing now in restricted areas were the oldest and not the youngest.

Mr. Julian Huxley contended that many factors played a part in evolution. Species characters should be analysed by the methods of genetics and physiology before it could be said which were useless. Apparently useless characters in the Gipsy moth were correlated with physiological differences, such as rate of growth, which harmonised with the environment.

Prof. R. Ruggles Gates considered that Dr. Willis's view was a corollary of the mutation hypothesis, and emphasised the importance of the extinction of forms as a factor in evolution.

Prof. W. J. Dakin suggested that biologists were on the threshold of a new line of study of evolution from the physico-chemical side. He believed that the faculty of evolution was as much a character of the organism as irritability or reproduction, and pointed out that natural selection was really natural elimination, the production of characters being inherent properties.

Dr. A. B. Rendle said it was almost impossible to say what characters were useful or not, and, in view of the limited space available, considered that the multiplication of genera and species in geometrical progression was unlikely.

Prof. J. Stanley Gardiner agreed that evolution was an inherent property of protoplasm, and raised the question as to why forms of life died out. He expressed approval of the main thesis of "Age and Area."

In reply, Dr. J. C. Willis pointed out that there must be some reason for the uniformity of expression as given in his statistical work. He accepted the phrase "Natural Elimination" instead of "Natural Selection."

In concluding the discussion, Prof. H. H. Dixon pointed out that both "Natural Selection" and "Age and Area" were essentially truisms, but none the less required explicit statement and demonstration.

Effects of Local Conditions on Radio Direction-finding.

THE methods used for finding the direction in which Hertzian waves are incident at a radio station have now attained a high accuracy, the maximum error being well under one degree. It does not follow, however, that the methods give the direction of the sending station to the same accuracy. The waves sent out may have suffered reflections from all kinds of conductors before they reach the receiving station. Hence, especially at night-time, the apparent direction generally differs very appreciably from the true direction. A preliminary report on this subject, communicated by the Radio Research Board, was read on November 8 to the Radio section of the Institution of Electrical Engineers by Messrs. Smith-Rose and Barfield. They classify the causes of distortion under two heads: First, those which are vaguely classed as night-effects and occur between sunset and sunrise. They are sometimes as large as 20°, and little is known as to their cause. Hence in practice radio-direction finding is restricted to day-time. The second causes of error are those due to conducting substances in the immediate neighbourhood of the search coil. In one experiment a metal tube 50 ft. long, semicircular in cross-section, and of radius 3 ft. 6 in. was used. When the coil was at a distance of 15 ft. from either end errors became appreciable, and when placed 15 ft. inside the tube the error was as great as 29°.

Experiments were also made on board ship, as radio-direction finding is of great value in navigation. It was found that when the waves came fore-and-aft or athwart the ship there was no error, but that in intermediate positions the errors were sometimes as great as 22°. As these errors are approximately constant, corrections can be applied as in the case of the magnetic compass. Curiously enough it was found that underground metal work in the neighbourhood had a very appreciable effect on the apparent direction of the incoming waves. The Aberdeen University direction-finding station, for example, was erected on what was thought to be a favourable site. The errors found, however, indicated the existence of a long strip of metal in the neighbourhood in a definite direction. The authors investigated the cause and found that a sewer in the neighbourhood, which was in the given direction, was supported by a strip of steel 6 ft. wide, 300 ft. long, and 8 ft. below the surface.

Overhead wires also caused appreciable but variable errors, which the authors traced to variations of the telegraph and telephone circuits when in use. They investigated the errors produced by tuned aerials and trees. Trees when damp have small resistance, and so the oscillations set up in them affect the direction of the waves. A row of damp trees forms a very good conducting screen. It was noticed that the waves showed a tendency to move round large conductors. Owing to variable meteorological conditions a very large number of experiments had to be made before definite results were obtained. The authors are continuing theri investigations.

New X-ray Department at Manchester.

SIR HUMPHRY ROLLESTON, president of the Royal College of Physicians and of the Röntgen Society, opened on November 18 the new X-ray department of the Manchester Royal Infirmary, which is probably the most completely equipped department of its kind in this country. This has been made possible by two separate gifts of 5000*l.*, one by Mr. Robert McDougall and the other by an anonymous benefactor.

The occasion coincided with a joint provincial meeting at Manchester of the Röntgen Society and the Electrotherapeutics Section of the Royal Society of Medicine; and a considerable number of members took the opportunity of inspecting the new equipment, which has been installed by Messrs. Watson and Sons under the direction of Dr. A. E. Barclay, senior radiologist to the Infirmary

The new department is on the ground-floor, is well lighted and ventilated, possesses generous head room, and is cheerfully decorated, all features which are

stressed in the recommendations of the X-ray and Radium Protection Committee. Indirect lighting is employed, the ceilings being painted with white enamel.

Throughout the building high-tension wires are abolished. They are replaced by stout aluminium tubing, which eliminates brush discharges and prevents the formation of ozone, now known to be prejudicial to the health of the operators.

Most of the X-ray bulbs are contained in boxes which are covered with an adequate thickness of sheet lead. In addition, the walls are coated with a plaster containing a large admixture of barium sulphate, the result being a wall giving protection equivalent to that of about 8 mm. of lead.

Coolidge tubes and closed-core high-tension transformers are the order of the day, except in the treatment department, where the existing induction coils have been brought up-to-date.

In the screening-room a Sunic 10 K.V.A. oil-immersed transformer is installed. The new intensive deep therapy treatment of cancer is catered for by two separate 200,000-volt outfits, each of the twin-coil type—one a German set with dry insulation by Maison Schaerer, the other of the oil-immersed type by Newton and Wright.

There are a number of unusually elaborate screening-stands and couches, a novel development being the Potter Bucky couch, in which a lead grid is inserted between the patient and the photographic plate. The grid, while allowing direct X-rays from the bulb to pass, prevents the majority of the scattered radiation from reaching the plate, to the marked benefit of definition. A special portable X-ray equipment is provided for use in the wards of the hospital in cases where it is inadvisable to move the patient.

The lay-out of the department is well-nigh a model of its kind, being arranged so that the work progresses automatically to its finality. The day of black-painted walls for dark rooms is over; instead, we find a cheery lofty room which can readily be flooded with daylight when the room is not in use. Thermostatic control of the developing and fixing solutions, etc., is provided. There is also a fully-equipped demonstration room, so that doctors and students can watch the examination of cases without hampering the work. This demonstration room is also provided with a stereo-motorgraph, an ingenious instrument which automatically changes lantern slides by a press-button, so that the lecturer is independent of a lantern operator. The proportion of infirmary patients requiring X-ray examination is one in five, so that business-like and orderly arrangements are very essential.

At the joint meeting Prof. Jacobaeus of Stockholm, Prof. W. L. Bragg and Prof. A. V. Hill, among others, contributed papers; and the enterprise of the two societies in departing from precedent by holding a meeting in the provinces met with great local appreciation and support.

University and Educational Intelligence.

ABERDEEN.—Dr. A. W. Gibb has been appointed to the newly founded Kilgour chair of geology. This foundation is derived from a bequest under the will of the late Dr. Alexander Kilgour of South Loirston, supplemented in the will of his son, through whose death it has now become available. In accordance with the terms of the trust deed, junior and senior scholarships in natural science have also been instituted. Prof. Gibb, who has an intimate knowledge of the geology of the north of Scotland, has been in charge of the teaching of the subject since 1899, first as a member of the staff of the natural history department, and since 1908 as head of an independent department of geology. The teaching of the subject in Aberdeen is associated with the names of James Nicol and Alleyne Nicholson.

Prof. E. W. Hobson has completed, during the present month, his second series of Gifford lectures on "The Domain of Natural Science." In this series, which concludes the course, he has reviewed the whole field of natural science, and has dealt with its relation to general thought and to theism. The lectures will appear in book form.

LIVERPOOL.—We understand that Prof. F. Carey is to retire at the end of the present session. Prof. Carey is head of the department of pure mathematics at the University, and was one of the original professors on the first staff of the University College.

THE Strasbourg correspondent of the *Times* states that the diploma of doctor *honoris causa* of the University of Strasbourg has been conferred upon Sir James Frazer, author of "The Golden Bough."

ACCORDING to the Paris correspondent of the *Times*, the degree of doctor *honoris causa* of the University of Paris has been conferred on the following: Prof. Bordet, professor of bacteriology in the University of Brussels; Prof. M. Lugeon, professor of geology in the University of Lausanne; and Prof. A. Michelson, professor of physics in the University of Chicago.

BY the will of Sir William Stevenson Meyer, High Commissioner for India and formerly Chief Secretary to the Government of Madras, who died on October 19 last, sums of 3000*l*. each are bequeathed to University College, London, "for the encouragement of proficiency in European history and in the history and geography of India," and to the University of Madras "for promoting the study of history and economics."

A CONFERENCE on the teaching of science in schools and colleges, which owed its initiation to Miss Winifred Smith, president of the Association of University Women Teachers, and its organisation to the joint efforts of the Association of Science Teachers and the A.U.W.T., was held on Saturday, November 25, at University College. During the morning session, with Miss Smith in the chair, the more general aspects of science teaching and the relationship between the work in the school and in the university were discussed. In the opening paper Sir William Tilden dealt with science in the school and raised a plea for work of wider and less specialised type, with a place for the history of the growth of knowledge. His personal reminiscences added much to the interest of the paper. Sir William Bayliss and Prof. J. R. Partington both expressed themselves in hearty support of wider range in the science work. The last speaker, from the point of view of university work, considered that the more specialisation was pushed in the school, the worse the result later. The condemnation of specialisation was continued in the papers of both Miss Thomas and of Miss Drummond. The first speaker dealt with the preparation of the student for the work of teaching science and deplored the tendency to specialise too early at the university; she considered the conditions of the Burnham scales enhanced this. The afternoon session included a paper upon the teaching of biology by Mr. A. G. Tansley, and papers upon

schemes of work in physics and nature study by Miss Lees and Mr. Latter respectively. The duty of the school to instruct future citizens regarding the functions of their own bodies was raised by several speakers. During the day, through the kindness of the college authorities, there was an opportunity to visit the laboratories, which was greatly appreciated by the members of the well-attended conference.

THE *Chemiker Zeitung* of September 28 publishes particulars as to the number of students in German universities. The total number had increased from 40,000 to 60,000 at the outbreak of war. At the end of the war the number was 90,000, and in the summer of 1921 it was 87,147. At present it is 82,668. The Technischen Hochschulen had 12,000 students before the war, in 1920 they had 22,976, and last winter 25,556. The division into faculties has undergone changes; the warnings of overcrowding in some faculties have had some effect but the stream of superfluous students has mainly been diverted into other faculties, which are also now hopelessly overcrowded. The following comparison is given with pre-war conditions:

Faculty.	1914.	1922.
Evangelical Theology	4,370	2,974
Catholic Theology	2,050	1,795
Legal Science	9,840	16,834
Medicine	16,048	15,110
Dentistry	976	4,167
Philosophy and Philology	14,400	12,823
Mathematics and Natural Sciences	8,132	9,257
Pharmacy	1,100	1,112
National Economy	3,836	17,714
Forestry	..	490

The following refer to technical students:

Faculty.	1914.	1922.
Architecture	2,193	1,811
Constructional Engineering	2,767	3,311
Mechanical Engineering	3,118	8,306
Electrotechnics	1,307	5,129
Mathematics and Natural Sciences	1,544	3,735
Mining and Metallurgy	576	1,234
Naval Engineering	234	365
General	493	1,483

It is further stated that the present-day student does not tend to the same extent as before the war to study in the large cities.

LIFE in the universities of Russia to-day is described by Harold Gibson, Chief Administrator, International University Relief in Russia, in a brief note circulated for the purpose of obtaining further help for their professors and teachers. While conditions in Moscow and Petrograd are said to have improved materially during the past year, they are still deplorable in the provinces. Professors and teachers have been receiving from the Government food packets (academical *pyok*), but it is doubtful whether this supply, inadequate and irregular during the summer, will not cease altogether during the winter. In addition they receive, but not regularly, pay on a scale sufficient to provide food (millet gruel with sunflower oil, soup made from salt fish, and potatoes fried in oil) for about one week per month. All clothing they could possibly do without during the summer is said to have been sold. As for housing, it is seldom that a professor's family has more than two rooms to live in and very frequently they have only one, while in some universities the professors live in their lecture-rooms or laboratories. It is astonishing that under such conditions work of any value can be done, but we are assured that not merely is a respectable standard of instruction maintained but valuable research work has been done. An appeal by the Universities Committee of the Imperial War Relief Fund issued in September last met with an immediate and generous response, but much more is needed urgently—money, gifts in kind of food, clothing, and clothing material, books, scientific journals, and laboratory equipment. Full particulars can be obtained from Miss Iredale, Organising Secretary of the Committee, General Buildings, Aldwych, London, to whom cheques made payable to the Hon. Cecil Baring should also be sent.

THE Council of the League of Nations has approved and published a report on "The condition of intellectual life in Austria," specially prepared by Prof. de Reynold, of the University of Berne, during the month of August. It describes a struggle for existence carried on in circumstances of increasing difficulty which threaten to overwhelm completely Austrians who are dependent for their means of livelihood on intellectual work. "The winter of 1922–1923 will without a doubt be decisive." The University of Vienna is at present saved from having to close its doors by a Government subsidy of 1000 million crowns (the purchasing power of which is about one-twentieth part of the subsidy it was receiving before the war), but all practical scientific work has become impossible owing to lack of funds for the purchase of essential requisites. The Universities of Graz and Innsbruck and other institutions of higher education are in a similar or worse plight. Innsbruck formerly attracted many foreign students, but last year none except Austrians attended, and there is talk of closing, if not the whole university, at least the school of medicine. Academies and scientific societies continue to meet but are unable to publish reports except when, as occasionally happens, a foreign patron provides funds for the purpose. The monthly salary of a university professor is on an average about enough to live on for twenty days, and he may receive students' fees up to a sixth of his salary. Lectures go on in Vienna up to 10 P.M. to enable students to earn money by manual work (the only kind that is well paid) during the day. In the circumstances it is surprising that last year the University of Vienna still had nearly 10,000 students.

IN "Home Economics in Rural Schools" and "Modern Equipment for One-Teacher Schools" (Home Economics circular 13 and Rural School leaflet 3, 1922, of the Bureau of Education, Washington) a prominent place is given to the provision of hot lunch for the pupils. It has been found that in such schools the most satisfactory method of imparting a knowledge of foods and household sanitation and inculcating right health habits is in connexion with the preparation and service by groups of children of a hot lunch for the whole school. It is claimed that the time taken from the regular school work is not more than ten minutes daily, and that the beneficial physical effects of the hot food itself, and the moral effect of the co-operative social activity involved, have been very marked. It is recommended that the instruction in home economics should be related to the geography, arithmetic, and physiology lessons. In "Reorganization of Home Economics in Secondary Schools" (Bulletin 5, 1922) it is stated that the most satisfactory and economical management of the school lunch in any school, large or small, is attained by placing it under the direction of the head of the home economics department.

Calendar of Industrial Pioneers.

December 3, 1863. John Watkins Brett died.—A pioneer of submarine telegraphy, Brett obtained permission in 1847 from Louis Philippe to establish connexion by cable between England and France, a project which was first carried out in 1850.

December 4, 1804. Philippe Le Bon died.—In France, Le Bon is regarded as the inventor of lighting by gas. Educated for the Government service, in 1794 he became a professor in the École des Ponts et Chaussées. Three years later he was able to light his house at Bruchay by the distillation of wood, and in 1799 he was granted a patent. On December 4, 1804, he was found in the Champs-Elysées murdered by an unknown hand.

December 6, 1777. Johann Andreas Cramer died.—Regarded as the greatest assayer of his time, Cramer was born in Quedlinburg in 1710, taught assaying in Leyden and London, and afterwards was councillor of mines and metallurgy at Blankenburg. His "Docimasia" was published in 1736 and his "Elementa Artis Docimasticæ" in 1739.

December 6, 1892. Werner von Siemens died.—The eldest of the famous Siemens brothers, Werner Siemens was born at Lenthe, Hanover, on December 13, 1816, and in 1838 became an artillery officer. Distinguished for his scientific attainments, with John Georg Halske (1814–1890) he founded in 1847 the firm of Siemens and Halske at Berlin, and the following year with Himly laid the first telegraph line in Germany. He made many discoveries in electricity, in 1866 gave half a million marks for the founding of an Imperial Institute of Technology and Physics, and in 1888 was ennobled.

December 7, 1880. Henry R. Worthington died.—The original inventor of the direct-acting steam pump, of which many thousands of various types are manufactured annually, Worthington took out his first patent in 1841, and in 1845 founded the Worthington Hydraulic Works of New York, which became the leading establishment for the construction of steam-pumping machinery in the United States.

December 7, 1894. Ferdinand Viscomte de Lesseps died.—The originator and constructor of the Suez Canal, one of the great engineering works of last century, de Lesseps was born at Versailles in 1805, and at the age of twenty joined the French diplomatic service. Among other places he served at Cairo and Alexandria. Obtaining a concession from Said Pasha in 1854, he started the canal in 1858; a vessel of 80 tons passed from the Mediterranean to the Red Sea in 1867, and on November 17, 1869, the canal was formally opened. A colossal statue of de Lesseps stands at Port Said. De Lesseps also launched the scheme for the Panama Canal, and when an old man of eighty-eight was with the other directors found guilty of mismanagement and sentenced to a term of imprisonment, which, however, was not enforced.

December 8, 1870. Thomas Brassey died.—At a period when railways were first coming into extensive use, Brassey with various partners carried out some hundreds of important contracts including railways in England, France, Italy, Canada, Australia, Argentine, and India.

December 9, 1814. Joseph Bramah died.—Known for his invention of a safety lock, a beer engine, the hydraulic press, and a machine for numbering and dating banknotes, Bramah was a native of Yorkshire, but for many years was one of the leading mechanicians in London. E. C. S.

Societies and Academies.

LONDON.

Linnean Society, November 2.—Dr. A. Smith Woodward, president, in the chair.—A. B. **Rendle**: Early specimens of the dahlia and chrysanthemum from the Banksian Herbarium.—J. S. **Huxley**: The courtship of birds.—B. Daydon **Jackson**: The use of the name Forstera or Forsteria. Both names were used by Linne on a sheet in his herbarium with his note *Fostera vaginalis* on a sheet which formerly had a grass-like plant glued upon it and therefore was widely separated from the Stylidiaceous genus which at the present day bears the name Forstera.

Aristotelian Society, November 6.—Prof. A. N. Whitehead, president, in the chair.—A. N. **Whitehead**: Uniformity and contingency (presidential address). Our awareness of Nature consists of the projection of sense-objects into a spatio-temporal continuum either within or without our bodies. But "projection" implies a sensorium which is the origin of projection. This sensorium is within our bodies, and each sense-object can be described as located in any region of space-time only by reference to a particular simultaneous location of a bodily sensorium. The process of projection consists in our awareness of an irreducible many-termed relation between the sense-object in question, the bodily sensorium, and the space-time continuum, and it also requires our awareness of that continuum as stratified into layers of simultaneity, the temporal thickness of which depends on the specious present. If this account of Nature be accepted, then space-time must be uniform, for any part of it settles the scheme of relations for the whole irrespective of the particular mode in which any other part of it, in the future or the past or elsewhere in space, may exhibit the ingression of sense-objects. Accordingly, the scheme of relations must be exhibited with a systematic uniformity. We have here the primary ground of uniformity in Nature.

Mineralogical Society, November 7 (anniversary meeting).—Dr. A. Hutchinson, president, in the chair.—W. A. **Richardson**: The frequency-distribution of igneous rocks in relation to petrogenic theories. The distribution of igneous rocks shows a separation into two primary types, probably corresponding to two primary earth shells, which have originated under early planetary conditions. All other rocks are normally distributed about the two primaries, and the probable cause of such a distribution is fractional crystallisation. The frequency-distribution likely to result from different petrogenic processes is examined and discussed.—Miss I. E. **Knaggs**: The connexion between crystal structure and chemical constitution of carbon compounds. In certain simple substitution products of methane, the crystal symmetry may be predicted from the known configuration of the chemical molecule. The symmetry of a molecule of the type CX_4 is that of a regular tetrahedron, X being either a univalent atom or a group of atoms, which does not destroy the trigonal symmetry about the bonds from the central carbon atom. Compounds of this type crystallise in the cubic system. Compounds in which X is a more complex group, but sufficiently symmetrical to maintain tetragonal symmetry, crystallise in the tetragonal system, most frequently in the holohedral class, in which case the crystal is considered to be built up of cells each containing eight molecules. Molecules of the type CX_3Y have one axis of trigonal symmetry, and this symmetry is preserved in the crystal, except when X is hydrogen. The orthorhombic symmetry of molecules of the type CX_2Y_2

is maintained in the crystal.—Dr. G. T. **Prior**: The meteoric iron of Karee Kloof, Cape Province, and the meteoric stone of Leeuwfontein, Pretoria, South Africa. The meteoric iron, of which a mass of 92 kgm. was found at Karee Kloof, is a coarse octahedrite containing 8·27 per cent. nickel; the Leeuwfontein meteoric stone of 460 gm. which fell on June 21, 1912, is an intermediate chondrite.

Zoological Society, November 7.—Prof. E. W. MacBride, vice-president,. in the chair.—C. S. **Elton**: The colours of water-mites.—E. B. **Poulton**: Commensalism among Crustacea. An account of experiments conducted at the Laboratory of the Marine Biological Association, Plymouth, in 1890, showing commensalism may be beneficial to Crustacea. —G. M. **Vevers**: Nematode parasites of mammals from the Zoological Society.—W. J. **Kaye**: New species of Trinidad moths.—C. F. **Sonntag**: On the myology and classification of the wombat, koala, and phalangers.—E. G. **Boulenger**: Description of a new lizard of the genus Chalcides, from the Gambia, living in the Society's Gardens.

Geological Society, November 8.—Prof. A. C. Seward, president, in the chair.—R. D. **Oldham**: The earthquake of August 7, 1895, in Northern Italy. This earthquake, although nowhere more than a feeble shock, was felt over an area measuring about 160 miles across and covering some 15,000 to 20,000 square miles in Lombardy and Tuscany. There is no indication of a central area of greatest intensity; reports indicating an intensity of IV° (Mercalli scale) are scattered over the whole area, and reports of sounds and of noticeable vertical movement are similarly distributed. The nature of the disturbance was akin to that in the outer parts of the seismic area of great earthquakes. The depth of the ultimate origin of the earthquake must have been of the order of 100 miles or more.—R. D. **Oldham**: The Pamir earthquake on February 18, 1911. This earthquake was felt over an area of about 250 miles in diameter; the region included by the VIII° R.F. isoseist measured about 40 miles across. Over the greater part of this area destruction was extreme, and the hillsides were seamed with landslips. Aftershocks were recorded, providing further evidence that the earthquake had its origin at a considerable depth below the surface. The great landslip, though determined by, and not determining the earthquake, as has been thought in the past, may have influenced the distant seismograms by setting up surface-waves which, superimposed on those directly due to the earthquake, may account for the unusual size of the long (or surface-) waves, as compared with the preliminary tremors.—F. **Dixey**: The geology of Sierra Leone: About half of the Protectorate of Sierra Leone is composed of potash-bearing granites and granite-gneisses, while the remaining areas are occupied equally by older schists and gneisses and the ancient sedimentary Rokell River Series. The older schists and gneisses, including a charnockitic series similar to that of the Ivory Coast, represent a complex of highly metamorphosed sedimentary and igneous rocks. The Rokell River Series has a lower conglomeratic division that rests unconformably upon the crystalline rocks. The rocks of the series are usually much disturbed, and show every gradation from slight deformation to intense dynamic metamorphism. The southern margin of the great series of horizontal sandstones of French Guinea forms, near the Anglo-French boundary of the Protectorate, the Saionia Scarp, and thus the formation within the Protectorate bears the name Saionia Scarp Series. It rests alike with striking unconformity upon the Rokell River Series and the crystalline rocks.

Association of Economic Biologists, November 10. —E. S. **Russell**: The work of the Fisheries Laboratory at Lowestoft. The main task of the past two years of the Laboratory and research ship *George Bligh* has been the working out of the life-history and food supply of certain economic fishes. Investigations on plaice in the North Sea have shown that there are more plaice than before and they were markedly larger and older than the pre-war plaice. In connexion with cod and herring investigations a quantitative study of the bottom fauna, carried out by Petersen's method on an area of the Dogger Bank, showed that the food supply was very patchy. Large patches of *Mactra (Spicula) subtruncata*, which is a plaice food, were found. The fauna belonged generally to the Venus community, with a tendency to deep Venus. Investigations of the early stages of the herring led to searching for spawning areas. Useful pointers have been the catches of spawn-gorged haddocks landed on the East Coast. Larval and post-larval forms were secured chiefly by using the Petersen young fish trawl. There is a spawning ground off the Lincolnshire coast, and others off the Northumbeiland coast, on the W. edge of the Dogger, and in the Southern Bight, etc. At an early stage young herring concentrate in inshore waters and go in shoals, which complicates quantitative investigations. The failure of last year's herring fishery on the E. coast of England is thought to be related to an abnormal influx of Atlantic water into the N. Sea. Concomitantly, changes occurred in temperature, salinity, and plankton fauna. Very young herring, even before the yolk sac is absorbed, prefer Pseudocalanus as food; a later stage takes Temora, and herring of whitebait size take Eurytemora.—S. F. **Harmer**: The present position of the whaling industry.

Linnean Society, November 16.—Dr. A. Smith Woodward, president, in the chair.—A. J. **Wilmott**: *Orchis latifolia*, Linn. (marsh orchis) from the Island of Öland, Sweden, obtained from the station in which it was found by Linnæus in 1741. *O. latifolia*, L., 1753, was a general name for marsh orchids, but in 1755 this name was limited without varieties, and separated from *O. incarnata* and *O. sambucina*. The diagnosis is general, and comes from Linnæus's article in Act. Upsal. 1740, where it applies mainly to unspotted-leaved plants. Linnæus, referring to *O. latifolia* in 1755, says that the leaves are slightly spotted. This may refer to the decay spots on the plant in his herbarium, or to the hybrid forms with spotted leaves which occur where *O. prætermissa* and *O. maculata* occur together.—T. A. **Sprague**: Twin-leaves and other abnormalities in the common ash, *Fraxinus excelsior*. Specimens were shown with fasciated stems, bud-variation, accessory leaflets, confluent leaflets, twin-leaves and triplets, and other abnormalities. Twinning is probably caused by hypertrophy. Complete or partial suppression of one leaf of a pair does not necessarily disturb the opposite-decussate phyllotaxy.

Faraday Society, November 20. — Sir Robert Robertson, president, in the chair.—T. M. **Lowry**: Intramolecular ionisation. The introduction of electronic formulæ based on the theory of octets has made it necessary to postulate a condition of intramolecular ionisation in a large number of compounds where the charges on the nuclei are not balanced by the enveloping electrons. Stability in oxy-acids depends on the presence of a positive charge on the central atom of the ion. This also increases the strength of the acid. A maximum of stability and

of strength is reached in acids containing four atoms of oxygen round the central atom of the ion.—C. J. **Smith**: On the viscosity and molecular dimensions of hydrogen selenide. Attention has recently been directed to the relations which exist between the molecular dimensions of those gaseous hydrides which have the same molecular number. In the series krypton, hydrogen bromide, hydrogen selenide, and arsine there were no data for hydrogen selenide. Two factors are necessary for the proper estimation of dimensions of a gaseous molecule, namely, the coefficient of viscosity, and its rate of variation with temperature. The viscosity of hydrogen selenide at atmospheric temperature has been measured, but the almost complete decomposition of the gas at steam temperature has prevented any trustworthy experimental determination of the temperature variation being made. The numerical results obtained confirm the supposition that the gaseous molecules HBr, H_2Se, and AsH_3 have a central atom which resembles an atom of krypton, and that the increase in A in passing along the series is to be attributed to the hydrogen nuclei which have become attached to the central atom. As the hydrogen atoms in the molecule multiply, the distance of each hydrogen nucleus from the centre of the molecule increases more and more rapidly.—W. R. G. **Atkins**: The hydrogen concentration of natural waters and some etching reagents in relation to action of metals. The results obtained are summarised as follows: Natural waters are usually between pH6 and pH8·3, unless when rendered more acid by oxidation of sulphur from pyrites or by metallic salts. Bog pools may be as acid as pH5. Photosynthesis increases the pH value. Ferrous salts in solution become more acid on standing, with precipitation of ferric hydroxide. The latter is completely precipitated before ferrous hydroxide, as the solution is made progressively more alkaline. Even at pH7·1 the precipitation of ferrous hydroxide is incomplete. Hence a trace of acid suffices to attack iron, and the hydroxide produced through hydrolysis is oxidised and precipitated. The hydrolysis equilibrium is thereby upset and acid is regenerated. Buffer mixtures and acids of relatively low hydrogen ion concentration might be used as etching agents.

CAMBRIDGE.

Philosophical Society, October 30.—Prof. A. C. Seward, president, in the chair.—H. **Hartridge** and F. J. W. **Roughton**: Determinations of the velocity with which carbon monoxide displaces oxygen from its combination with the blood pigment hæmoglobin. The velocity of the reaction, which is considerable, was measured by utilising the fact that light displaces the system from equilibrium by reducing the amount of the carbon monoxide hæmoglobin in a solution of hæmoglobin containing oxygen and carbon monoxide. The relationship between the amounts of the oxy- and carbon monoxide hæmoglobin at any moment was determined by the reversion spectroscope, which makes use of the fact that the wavelength of the α band of the mixed pigment varies with the relative concentration of the pigments. Two methods of measuring the velocity of reaction were employed:—(*a*) The solution was caused to flow turbulently from a glass tube exposed to light, down a second glass tube in the dark. In this tube the equilibrium returned to its "dark" position, and from the rate of flow measurements by the spectroscope give the relative amounts of oxy- and carbon monoxide hæmoglobin at any moment. (*b*) The solution remained in one vessel, the exposure to light being suddenly cut off, and the time measured with a chronometer for the relationship between the oxy- and carbon monoxide hæmoglobin to reach a definite value as shown by the spectroscope. Velocity constants were calculated, assuming the reaction to be expressible by a simple chemical equation. The temperature coefficients calculated from the results obtained at other temperatures agree closely, the mean value being 2·5. These results fit in with the view that the combinations of oxygen and carbon monoxide with hæmoglobin are of a simple chemical nature.—G. H. **Hardy** and J. E. **Littlewood**: Some problems of Diophantine approximation.—**J. Chadwick** and C. D. **Ellis**: A preliminary investigation of the intensity distribution in the β-ray spectra of radium *B* and *C*.—C. G. **Darwin** and R. H. **Fowler**: Partition functions for temperature radiation and the internal energy of a crystalline solid.—J. E. **Littlewood** and E. A. **Milne**: On an integral equation.—E. V. **Appleton**: The automatic synchronisation of triode oscillators.—P. L. **Kapitza**: Note on the curved tracks of β-particles.—G. T. **Walker**: Meteorology and the non-flapping flight of tropical birds.—Major P. A. **MacMahon**: The algebra of symmetric functions.

DUBLIN.

Royal Irish Academy, November 13.—Prof. Sydney Young, president, in the chair.—S. **Young**: A note on azeotropic mixtures. It is now possible to predict, either with certainty or with considerable confidence, whether an alcohol of the methyl alcohol series not yet investigated can or cannot form a binary mixture of minimum boiling-point with hexane, benzene, or toluene, or a ternary azeotropic mixture with one of these hydrocarbons and water.

PARIS.

Academy of Sciences, November 6.—M. Albin Haller in the chair.—The president announced the death of E. Bouty.—L. **Lindet**: Concerning the coagulation of latex. Remarks on a communication by M. Vernet on the effects of adding calcium chloride solution to the latex of rubber plants. In 1914 the author published an account of a similar action of calcium chloride in the coagulation of milk casein.—Jean **Effront**: The absorption of pepsin and hydrochloric acid by foods. Starting with the observation that certain filter papers proved to be active absorbents of pepsin, experiments have been carried out on the absorptive powers of various fruits and vegetables for pepsin and also for hydrochloric acid. The amounts absorbed were considerable, and vary with the fruit and with the acidity of the medium. The therapeutical aspects of these facts are discussed.—Serge **Bernstein**: The asymptotic development of the best approximation by polynomials of rational functions of degrees indefinitely increasing.—Birger **Meidell**: A problem of the calculus of probabilities and of mathematical statistics. A discussion of Tchebycheff's theorem on the probabilities of errors greater than the average error with special reference to the calculus of probabilities and mathematical statistics.—P. J. **Myrberg**: The singularities of automorphic functions. A correction to the note of October 23 on the same subject.—J. **Le Roux**: Gravitation in classical mechanics and in Einstein's theory.—Louis **de Broglie**: Interference and the quanta theory of light.—Paul **Pascal**: The magnetic analysis of silicates and the silicic acids. From measurements of magnetic susceptibility of silicic acid in varying degrees of hydration it is concluded that all the forms of "hydrated silica" studied behave magnetically as mixtures of anhydrous

silica and water. There is no evidence in favour of the existence of any definite silicic acids in the hydrated silica.—André **Brochet**: The preparation of active nickel for organic catalysis. Three methods are described, the reduction of black nickel oxide by electrolytic hydrogen at 350° C. (an operation requiring 48 hours), or by heating either nickel formate or nickel oxalate to 250°–300° C. These three varieties of active nickel possess practically identical catalytic properties.—A. **Aubry** and E. **Dormoy**: An arsenical glucoside: diglucosidodioxydiamino-arsenobenzene. The compound "606" has been made to combine with glucose and the reactions of the diglucoside formed are given. For therapeutic purposes the glucoside has the advantage as compared with "606" of being very soluble in neutral medium: it is also less alterable in air than the dioxydiamino-arsenobenzol.—Pereira **de Sousa**: The eruptive rocks of the Mesozoic and Cainozoic border of Algarye and their geological age.—C. **Kilian**: General sketch of the structure of the Tassilis of Ajjer.—Albert **Baldit**: Magnetic measurements in the south of France.—Sabba **Stefanescu**: The velocity of evolution and the general plan of structure of the crown of the molars of mastodons and elephants.—Marc **Bridel** and Camille **Charaux**: Centaureine, a new glucoside, extracted from the roots of *Centaurea jacea*. Details of the extraction and properties of the new glucoside are given. On hydrolysis, centaureine gives 33·7 per cent. of glucose (and no other sugar) and 70·8 per cent. of centaureidine.—E. and G. **Nicolas**: The action of hexamethylenetetramine on the higher plants.—Marin **Molliard**: The influence of salts of copper on the yield of *Sterigmatocystis nigra*.—Adrien Davy **de Virville** and Fernand **Obaton**: The opening and closing of persistent meteoric flowers. Persistent meteoric flowers are defined as those the floral parts of which show opening and closing movements during several days. These movements depend almost entirely upon the temperature. A reduction in the relative humidity of the air favours the opening of the flowers, but the effect is slight. Contrary to the views expressed by some physiologists light is without action.—Alphonse **Labbé**: The variations in the concentration of hydrogen ions in the salt marshes, considered as a biological factor.—M. **Bezssonoff**: The effect on guinea-pigs of an antiscorbutic preparation.

SYDNEY.

Linnean Society of New South Wales, August 30.—G. F. **Hill**: A new species of Mordellistena (Coleoptera, Mordellidæ) parasitic on termites. Description of a new species from Palm Island, N. Queensland, distinguished from all other Australian species of the genus by its large size and bright red prothorax. It is improbable that this parasite, of which the only known host is *Calotermes* (*Glyptotermes*) *nigrolabrum* Hill, could become a factor in controlling injurious species of termites.—W. W. **Froggatt**: Description of a new Phasma belonging to the genus Extatosoma. A female obtained at Gosford, N.S.W., differing from *Extatosoma tiaratum* W. S. Macleay, in its much more slender form, many more spines, different flanges on abdomen, and shape of legs.—W. A. **Haswell**: On Astacocroton, a new type of acarid. It is a parasite of the common spiny crayfish (*Astacopsis serratus*) of the rivers of New South Wales. It lives permanently in the gill-cavities of its host, and the mature females become permanently attached to the gills and incapable of active locomotion. The food consists solely of the blood of the crayfish. In structure Astacocroton is related to the hydrachnids, but shows certain special features, particularly in the female reproductive apparatus.—Vera **Irwin-Smith**: A new nematode parasite of a lizard. It possesses an asymmetrical row of spines down one side. Nothing like it has been found previously in reptiles. It is assigned, provisionally, to the genus Rictularia, a genus recorded, hitherto, only from mammals. Only two females have been found.—A. J. **Turner**: Revision of Australian Lepidoptera: Saturniadæ, Bombycidæ, Eupterotidæ, Notodontidæ. Of the first three families only fifteen Australian species are at present known. The fourth family, the Notodontidæ, is enlarged by the inclusion as a subfamily of the Cnethocampinæ, a small natural group of which the European Procession Moth is the type. Nearly seventy Australian species are recognised.

September 27.—Mr. J. J. Fletcher, vice-president, in the chair.—T. **Steel**: Chemical notes: General. Some curious ferruginous concretions surrounding twigs, leaves, and fruit of Hakea, from a chalybite pool near Fitzroy Falls, N.S.W., are described and figured, and an analysis given; also stalagmite from a grotto at Wentworth Falls, having a similar composition. Analyses are given of cubical pseudomorphs of pyrites, from Western Australia, called locally "Devils' Dice"; of lime prepared by the Fijians from coral and used for plastering the hair; of the shells of *Helix aspera*, the urinary secretion of birds and reptiles, the fruit of the banana, and milk of unripe coconuts.—Margaret H. **O'Dwyer**: A note on protein precipitation in grasses. Stützer's reagent (copper hydroxide), tannin salt solution, Barnstein's reagent (a variation of the copper hydroxide method) and alcohol (85 per cent.) were used as precipitants. Tannin salt solution and alcohol appear to give the best results.—Margaret H. **O'Dwyer**: Further report on the nutritive value of certain Australian grasses. Analyses are given of grasses at the early flowering period and when the seed is set. The protein present decreases with the age of the grass, while crude fibre is higher in the older stages. Diseased grasses showed slight divergences from normal.—W. F. **Blakely**: The Loranthaceæ of Australia (contd.), Pt. iii. Eight species and five varieties of the subgenus Euloranthus, of which one species and three varieties are new, are described.—M. B. **Welch**: The occurrence of oil-glands in the barks of certain Eucalypts. Oil-glands occur in the secondary bast of certain species of Eucalyptus (stems and roots). The contents of the secretory cavities become resinous and insoluble towards the outside of the bark. The function of the glands is probably protective.

Royal Society of New South Wales, October 4.—Mr. C. A. Sussmilch, president, in the chair.—H. G. **Smith**: On the occurrence of lævo-phellandrene in the oil of *Melaleuca acuminata*. The species occurs in South Australia and is locally known in Kangaroo Island as "Lavender bush." The yield of oil is about 2 per cent., and this consists principally of phellandrene and cineol, the latter to the extent of 44 per cent.—A. R. **Penfold**: The essential oils of two varieties of *Leptospermum flavescens*. The northern form of this species, *var. microphyllum*, was obtained from Frazer Island, and the other new variety, called *leptophyllum* (Cheel), from Narrabri. Both oils consist essentially of alpha and beta pinene, sesquiterpenes, and sesquiterpene alcohols, with small amounts of cineol; terpineol is present in the latter oil.

Official Publications Received.

Proceedings of the Cambridge Philosophical Society. Vol. 21, Part 3 (Easter Term, 1922). Pp. 129-296. (Cambridge: At the University Press.) 7s. 6d. net.

Proceedings, Asiatic Society of Bengal. (New Series.) Vol. 17, 1921, No. 4: Proceedings of the Eighth Indian Science Congress. Pp. lxxvii-ccxlviii. (Calcutta.)

Observations made at the Royal Magnetical and Meteorological Observatory at Batavia. Vol. 40, 1917, containing Meteorological and Magnetical Observations made in 1917. Pp. xx+106. (Batavia.)

Records of the Indian Museum. Vol. 21: Catalogue of the Planorbidæ in the Indian Museum (Natural History), Calcutta. Part 2. By Louis Germain. Pp. 81-128. (Calcutta: Zoological Survey.) 2 rupees.

Uganda Protectorate. Annual Report of the Department of Agriculture for the Year ended 31st December 1921. Pp. 87. (Entebbe.)

Diary of Societies.

MONDAY, DECEMBER 4.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Rev. C. Gardner: Romance and Mysticism.

ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 5.—A Twenty-one Minute Period in Earthquakes. *Chairman*: Prof. H. M. Macdonald. *Speakers*: Prof. H. H. Turner; Dr. J. H. Jeans.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

SOCIETY OF ENGINEERS, INC. (at Geological Society), at 5.30.—W. Dinwoodie: Wave-Power Transmission.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—F. A. Sclater, and others: Discussion on an Electrical Installation at a Model Farm.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—G. Cator: The One and the Many.

ROYAL SOCIETY OF ARTS, at 8.—Prof. W. A. Bone: Brown Coal and Lignites (Cantor Lecture).

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Engineers' Club, 39 Coventry Street), at 8.—Dr. G. S. Robertson and F. Dickinson: The Valuation of Insoluble Phosphate by Means of a Modified Citric Acid Test.

ROYAL SOCIETY OF MEDICINE (Tropical Diseases and Parasitology Section) (Informal Meeting), at 8.30.—Prof. R. T. Leiper: Kinematograph Film of British Guiana: Its People, Natural History, and Scenery.

TUESDAY, DECEMBER 5.

ROYAL SOCIETY OF ARTS (Dominions and Colonies Section), at 4.30.—Major O. Rutter: North Borneo.

ROYAL SOCIETY OF MEDICINE (Orthopædics Section), at 5.30.—H. A. T. Fairbank and others: Discussion on The Operative Treatment of Dislocation of the Hip, Congenital and Pathological.

INSTITUTION OF CIVIL ENGINEERS, at 6.

BRITISH PSYCHOLOGICAL SOCIETY (Annual General Meeting) (at London Day Training College), at 5.30; at 6.—Dr. E. O. Lewis: The Memory of Feeble-minded Children.

INSTITUTE OF MARINE ENGINEERS, INC., at 6.30.—A. J. Brown: Marine Diesel Engines.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—C. L. Hind: The Lesson of Photography.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Miss E. Kemp: The Aborigines of Western China.

RÖNTGEN SOCIETY (at Institution of Electrical Engineers), at 8.15.

ROYAL SOCIETY OF MEDICINE (Pathology Section) (at St. Mary's Hospital), at 8.30.—Sir Almroth Wright: Immunisation *in Vitro*.—Dr. J. Freeman: Protein Sensitisation Experiments.—C. G. Schoneboom: Intertraction.—A. F. Hayden: Classification of Acne Bacilli.—Dr. A. L. Punch: Tubercle Complement Fixation with Cow's Serum.—Dr. A. Fleming, C. B. Dyson, and V. D. Allison: Anti-bacterial Properties of Egg White.—W. D. Newcomb and Dr. J. M. Ross: Demonstration of Pathological Specimens.

WEDNESDAY, DECEMBER 6.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—H. A. Baker: Final Report on Geological Investigations in the Falkland Islands. Prof. A. C. Seward and J. Walton: Fossil Plants from the Falkland Islands.

ROYAL SOCIETY OF MEDICINE (Surgery Section), at 5.30.—The President and others: Discussion on Mistakes in Diagnosis and Treatment and the Lessons to be Learned from Them.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—E. B. Moullin: A Direct-Reading Thermionic Voltmeter, and its Applications.

WOMEN'S ENGINEERING SOCIETY (at 26 George Street, Hanover Square), at 6.15.—E. S. Andrews: Patent Work for Women.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—E. W. Blair and T. S. Wheeler: A Note on the Estimation of Form- and Acet-aldehydes.—C. H. D. Clark: A Sliding Scale for the Convenient Titration of Strong Liquids by Dilution and Use with Aliquot Parts.—H. A. Peacock: Note on the Presence of Sulphur Dioxide in Cattle Foodstuffs after Fumigation.—D. W. Steuart: Some Observations with regard to the Unsaponifiable Matter and Sterols of Edible Fats.—N. Evers and H. J. Foster: Note on the Sulphuric Acid Test for Fish Liver Oils.

ROYAL SOCIETY OF ARTS, at 8.—H. E. Chubb: Recent Developments in the Manufacture of Safes and Strong Rooms.

THURSDAY, DECEMBER 7.

ROYAL SOCIETY AT 4.30.—*Probable Papers*.—Lord Rayleigh: Spectrum of Active Nitrogen as affected by Admixture of the Inert Gases.—Dr. G. H. Henderson: Changes in the Charge of an α Particle passing through Matter.—W. T. Astbury: The Crystalline Structure and Properties of Tartaric Acid.—J. N. Mukherjee: Sources of Error in the Measurement of the Electrical Charge of Colloidal Particles by the Method of Moving Boundaries. An improved Method based on a Direct Measurement of the Potential Gradient across the Boundary.—J. Heyrovský: The Significance of the Electrode Potential.—A. M. Mosharrafa: On the Quantum Theory of the Simple Zeeman Effect.—Dr. S. Brodetsky: Discontinuous Fluid Motion past Circular and Elliptic Cylinders.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Prof. C. F. Jenkin: Fatigue in Metals.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—A. M. Taylor: The Possibilities of Transmission by Underground Cables at 100,000/150,000 volts.

CHEMICAL SOCIETY, at 8.—S. O. Rawling and W. Clark: The Isoelectric Condition of Gelatin.—H. J. S. Sand, E. J. Weeks, and S. W. Worrell: Studies on Metal Hydrides. The Electrolytic Formation of Stibine in Sulphuric Acid and Caustic Soda Solution.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology, Therapeutics and Pharmacology Sections), at 8.—Dr. H. H. Dale: The Value of Ergot in Obstetrical and Gynæcological Practice, with Special Reference to its Present Position in the British Pharmacopœia. To be followed by a discussion.

CAMERA CLUB, at 8.15.—B. Cox: Landscape—a Pot-pourri.

FRIDAY, DECEMBER 8.

ROYAL ASTRONOMICAL SOCIETY, at 5.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir William Thorburn: The Surgery of the Spinal Cord (Bradshaw Lecture).

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.—J. E. H. Roberts: Thrombo-angeitis obliterans.—Dr. G. Evans: Thrombo-angeitis obliterans.

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society), at 6.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—J. Ward: The Michell Thrust Bearing.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—G. Shearer: The Relation between Molecular and Crystal Symmetry as shown by X-Ray Crystal Analysis.—Dr. E. A. Owen and G. D. Preston: Modification of the Powder Method of determining the Structure of Metal Crystals.—Dr. A. B. Wood: The Cathode Ray Oscillograph.—A Demonstration of a low-voltage Oscillograph will be given by the Western Electric Company.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS, INC. (at Engineers' Club, Coventry Street), at 7.—Prof. A. H. Barker: Centrifugal Pumps as Applied to Heating Installations.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 8.—C. P. Crowther: The Man Behind the Camera and the Making of Portraits.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.30.—Continuation of discussion on the Significance of Vascular and other Changes in the Retina in Arterio-sclerosis and Renal Disease.

PUBLIC LECTURES.

SATURDAY, DECEMBER 2.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. E. Marion Delf: Vitamins and Health.

MONDAY, DECEMBER 4.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 5.—Prof. T. Madsen: Antitoxic Treatment (Harben Lecture).

CITY OF LONDON Y.M.C.A. (186 Aldersgate Street), at 6.—Gen. W. W. Ogilvy Beveridge: The Physique of the Nation.

TUESDAY, DECEMBER 5.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 5.—Prof. T. Madsen: The Influence of Temperature on Antigen and Anti-bodies (Harben Lecture).

UNIVERSITY COLLEGE, at 5.15.—A. J. Davis: The Principles of Architectural Planning.

WEDNESDAY, DECEMBER 6.

UNIVERSITY COLLEGE, at 5.30.—T. G. Hill: Illustrations of Books. Succeeding Lecture on December 13.

THURSDAY, DECEMBER 7.

BARNES HALL, ROYAL SOCIETY OF MEDICINE, at 5.15.—Sir Arthur Newsholme: Relative Values in Public Health (Chadwick Lecture). (1) Value of Vital Statistics, Sanitary Surveys and Professional and Popular Education. Historical Influence of General Sanitation, Specific Sanitation and Combined Action.

CITY OF LONDON Y.M.C.A. (186 Aldersgate Street), at 6.—Prof. H. C. H. Carpenter: What Metals Look Like Inside.

CENTRAL LIBRARY, FULHAM, at 8.—Prof. C. N. Bromehead: A Geologist's History of London.

FRIDAY, DECEMBER 8.

LEATHERSELLERS' HALL (St. Helen's Place), at 2.15.—Prof. G. H. Carpenter: The Warble Fly: Its History, and Methods of Extermination it.

UNIVERSITY COLLEGE, at 5.15.—Sir William H. Beveridge: The Civil Service.

BEDFORD COLLEGE FOR WOMEN, at 5.30.—Prof. H. E. Butler: Timgad: The North African Pompeii.

SATURDAY, DECEMBER 9.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: Ancient Egypt and the Bible.

SATURDAY, DECEMBER 9, 1922.

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A Suggested Royal Commission on Museums.

FROM time to time there appear in NATURE and elsewhere notes and articles that afford conclusive evidence of the valuable work done by our museums in scholastic education, in aid of industry on its technical as well as its artistic side, in the prevention of plant, animal, and human disease, in the general spread of beauty, and in the advancement of learning. But the work that is done is sparsely scattered through a large number of museums, and the isolated examples serve rather to show what might be accomplished than to give us cause for self-gratulation. There are in the British Isles about a score of national museums (supported, that is, in large part by Imperial taxation) and probably more than 350 museums and galleries supported mainly by local contributions. It would be no great exaggeration to say that scarcely two of these establishments are maintained and governed in quite the same way. Like so many other of our institutions they have originated at haphazard and have just "growed," generally by unorganised accretion. Consequently, while some have the desire and the means to be of use in one or other of the ways enumerated, more have the desire without the means, and many have neither the desire nor the means. In no case has a museum the power and the funds to make all that use of its treasures which could be made, and which its guiding spirits probably wish to see.

For some time past there have been efforts from various quarters to remedy the waste of material, waste of money, and waste of effort that are the consequences of overlapping, competition, lack of co-ordination, inappropriate administration, unequal distribution of funds, and all the other evils inherent in this disorder. The Ministry of Reconstruction tried to bring all the municipal museums, if no others, under the Board of Education, but the museums protested. An important committee of the British Association produced a valuable report on museums and education. Lord Sudeley by pegging away has induced the Government to pay for guide-lecturers in several of its museums, and has advocated with some success the sale of picture-postcards. The Museums Association, which represents the views of museum officials themselves, urges, among other reforms, that museum curators must be highly trained men and women of broad education, and recognises that the only way to get such people is to offer an adequate salary.

These movements are very well, but if we are to make the best use of our museums something larger is required. Mr. Bailey, in a paper read at the recent

conference of the Museums Association and now published in the *Museums Journal* (October 1922), supports Lord Sudeley in his demand for a Royal Commission. Mr. Bailey, who, as sometime secretary for the Circulation Collections at the Victoria and Albert Museum, knows the provincial museums on their art side better than most men, has no difficulty in making out a case for reform. He is particularly strong on the unjust and unequal incidence of the aid which, though diminished, is still given to local museums by the State through some of the national museums. The officers of the Government establishments, always so willing to help, would doubtless be glad to see the way made clearer for them. Mr. Bailey's criticism on these and other weaknesses is destructive. There are schemes enough in the air, and he does not add to them. He asks, and he has induced the Museums Association to ask, for a Royal Commission, so that any recommendations may ultimately be based on the fullest possible knowledge. We agree fully that there is need for reorganisation, and we believe that a large amount of reform might be effected without material increase of expenditure; indeed, some of the obviously desirable reforms would tend to economy. But, while we sympathise with the request of the museum folk for a Royal Commission, we fear that they are not now very likely to get it. The subject, indeed, deserves serious discussion and it would be well to have various proposals compared and investigated, so that when changes are effected they may be guided by a definite policy. Some inquiry, less expensive than that by a Royal Commission, might elicit the information and put forward an accepted ideal towards which all could work.

Any such inquiry should, however, approach the subject on the broadest possible lines. The resolution passed by the Museums Association asks for a "report upon the work of the museums of the United Kingdom in relation to industries and general culture." The importance of museums on the industrial side has been recognised by the Federation of British Industries in a recent report. "General culture" is an expression that may include much or little; presumably it is intended to comprise scholastic education. But there are the numerous activities of museums that aid the extension and application of knowledge in ways that do not seem to fall under these heads. Whatever their subject-matter, and whatever their immediate and distinctive aim, all museums work by the same method —the accumulation, preservation, and demonstration of concrete objects; they are guided by the same broad principles, and need the same kind of assistance. Though they may be co-ordinated with other social activities—industrial, educational, artistic, and the rest —they must not be confused with them. Any inquiry therefore must deal with museums as such, in relation to all their multifarious aims and activities, and must seek to bring all into one harmonious collaboration for the common weal.

Meteorological Theory in Practice.

(1) *Weather Prediction by Numerical Process.* By Lewis F. Richardson. Pp. xii+236. (Cambridge: At the University Press, 1922.) 30s. net.

(2) *Forms whereon to Write the Numerical Calculations described in "Weather Prediction by Numerical Process."* By Lewis F. Richardson. 23 forms. (Cambridge: At the University Press, 1922.) 2s.

IN the book under notice Mr. L. F. Richardson presents to us a *magnum opus* on weather prediction. The numerical manipulation of the dynamics and physics of the atmosphere is its mainspring; but there is a fine display of other works of an intricate character. Its avowed object is nothing less than the calculation of future events in weather; and this by inserting numerical values in seven fundamental formulæ, which, taken together, embody the essential analysis of the sequence of weather. Three of the equations express the time-rate of change of the easterly, northerly, and vertical components of the momentum of the air; other three express the time-rate of change of its density, water-content, and heat-content respectively. The seventh is the characteristic gas-equation for air; it contains no differentials.

The whole history of the atmosphere is to be unrolled on computing by finite differences the changes in the elements in terms of the changes of four independent variables representing space of three dimensions and time. The formulæ all relate to an individual sample of air in a column at a single point; but the calculation has to say what will happen to the whole mass in the neighbourhood of every specified locality within the region of observation. Hence representative points are chosen for which the changes of the variables are to be computed at a sufficient number of levels to give a working idea of the changes in the weather. The points are grouped in a lattice or chess-board with each square 200 kilometres long, 3° of latitude broad, and 2 decibars of pressure thick: the whole atmosphere is thus treated as made up of 16,000 slab-units each weighing about half a billion tons. What we call weather is represented by the physical changes in the slabs. The standard time-interval over which uniformity of change is preserved is six hours. Observations of pressure and temperature are taken for the centres of the "red" slabs of the chequer,

which lie in columns of five deep; observations of momentum at the centres of the "white." The changes in any one slab are computed with the aid of the known conditions of the surrounding slabs: hence the calculation for any arbitrary area is limited to the interior slabs, and the area amenable for computation diminishes with each step of the process. There is a great amount of original and ingenious scientific speculation and discussion in the description of the process.

Nearly a hundred separate algebraical symbols are employed. The author sketches a fancy picture of the process of computation going on for the weather of the whole world in a great theatre or forecast-factory in the form of a hollow globe. A spherical orchestra of computers calculates the future weather from the information supplied by 2000 stations under the direction of a conductor at the centre of the globe. In order to keep pace with the weather the orchestra would consist of 64,000 performers on the slide-rule or calculating machine; and even then, with a space unit of 200 kilometres, phenomena on the small scale, such as tornadoes or local thunderstorms, might be missed. Part of the appeal of the book is for a distribution of stations to be arranged so as to give the process of calculation a better chance than the existing distribution in Europe affords.

There are twelve chapters of very unequal length. Chapter I. is a brief summary of the contents of the book; Chapter II. is a simplified example of the method of calculation by finite differences which is to be used. This preliminary canter shows incidentally that a distribution of pressure according to an assumed geometrical law, and a universal geostrophic wind corresponding therewith, lead to the conclusion that a vast system of high pressure over the Eurasian continent, covering one half of the Northern hemisphere east of the meridian of Greenwich, would result in an increase of pressure over England, which lies on the margin. This result is regarded as axiomatically contrary to fact, because "cyclones" are known to pass eastward. We are therefore invited to conclude in passing that the geostrophic idea is inadequate. That is certainly a possibility but not the only one. Since the geostrophic idea is based upon our experience of natural distributions of pressure we might with equal justice conclude that the assumed geometrical distribution is a non-natural one. Or better still, we might say that Mr. Richardson's preliminary canter has given a rigorous dynamical explanation of what is meant by "an anticyclone resisting the advance of a cyclone," a very common statement of meteorological phenomena. The reviewer preserves in memory two natural pictures of an Atlantic cyclone kept at bay by a current from the east and presenting an appearance grotesquely like a revolving ball balanced on a water-jet. A notable feature of our northern winter is a vast anticyclone over Asia which dominates the northern half of the eastern hemisphere like Mr. Richardson's pattern, although the distribution over the other quadrants of the globe is not at all like the pattern. As a matter of experience the anti-cyclone does frequently spread from the east over England. Our weather might not inaptly be described as a conflict between the effect which Mr. Richardson repudiates as contrary to experience and the eastward travel of cyclones which he regards as axiomatic. Not infrequently, the result of the conflict is that the cyclones, instead of going eastward over us, are headed off to the north along the Norwegian Sea—"which nobody can deny."

In view of our inadequate knowledge of the structure and circulation of the atmosphere caution in drawing conclusions is always desirable, and in this case specially so in the interests of justice, because the alleged failure of the geostrophic principle to anticipate the changes at the surface in Chapter II. reappears in Chapter VI. as the record of a previous conviction, and gets the prisoner another sentence for what is perhaps not his fault. Mathematicians in dealing with the elusive atmosphere are not infrequently inspired by Jabberwocky,

> One two, one two, and through and through,
> The vorpal blade goes snickersnack;

but they ought to make sure that they get the right Jabberwock by the neck before "galumphing back" with his head.

Chapter III. reinforced by Chapter VII. explains a suitable organisation of what are called co-ordinate differences, the principles of the chess-board or lattice. Chapter IV., a very important one, occupies more than one-third of the whole book. It is devoted to the fundamental equations and the information which is necessary in order to assign numerical values for the variables. It takes the form of about thirty short essays on great subjects, such as the effects of eddy-motion, radiation, conduction of various kinds, the flow of heat to the air from the sea, or from the ground, or from vegetation, the smoothing of observations, and many others. Chapter V. deals with the evaluation of vertical velocity, a very vital subject. Chapter VI. deals with the special conditions for the stratosphere and its equations. Chapter VIII. reviews the numerical operations to be performed and gives the final preparation for Chapter IX., which provides a "full-dress rehearsal" of the process of computation. By its aid

the changes of pressure and temperature for a point near Munich and the changes of momentum at a point between Munich and Hamburg are calculated for the interval of six hours centred at 1910 May 20d. 7h. G.M.T. That day was chosen for displaying the method because a set of data for the surface and upper air was available in the publications of the Geophysical Institute of Leipzig issued by Professor V. Bjerknes. Although not quite adequate for the purpose it is an unusually full set.

The calculation occupied "the best part of six weeks" in a rest-billet in France. It included, however, the preparation of the forms which are now issued in blank for the use of others who may be attracted by the prospect of submitting the course of Nature to the process of numerical calculation. Every assistance is given by the forms and by suggestions for improving the accuracy, smoothing the data, and many other technical points of manipulation.

The trial specimen is not such a good example of the art of forecasting that it tempts the reader forthwith to become one of the great orchestra. The change of pressure at the surface works out at 145 millibars in six hours. Our barometers allow for a range of 100 millibars at most; and, as a matter of observation, the change in the region in question was less than a millibar: the wildest guess, therefore, at the change in this particular element would not have been wider of the mark than the laborious calculation of six weeks. Nor is that all. Many of the chapters end in parenthetic expressions of regret or of suggestions for improvement. There are also many supplementary paragraphs which indicate that when the author comes to make another edition, as he or some one else undoubtedly will, he will write somewhat differently. And the reader will not be sorry, for in many ways the book makes hard reading. It is full of mathematical reasoning, a good deal of which is conducted "by reference." The reader who wishes to follow it must have a very handsome library and a few stepladders which Mr. Richardson does not provide.

A reviewer with less than the ordinary sufferance of his tribe might easily murmur: forecasting by numerical process seems so arduous and so disappointing in the first attempts that the result is a sense of warning rather than attraction. He might also wonder for whom the author is writing, and regard the book as a soliloquy on the scientific stage. The scenes are too mathematical for the ordinary meteorologist to take part in and too meteorological for the ordinary mathematician. But such complaint would be as misleading as the computed forecast. On the road to forecasting by numerical process nearly every physical and dynamical process of the atmosphere has to be scrutinised and evaluated; the loss of view into the future from the first summit is compensated many times by the insight which one gets into the working of Nature on the way. For example, the author draws from the miss of his forecast the conclusion that the observations of velocity used are a real source of error. Whether that conclusion is true or not, its further consideration is of the greatest importance in view of the multiplicity of observations of winds in the upper air and of the difficulties which their interpretation presents.

The essential obstacle in the way of bringing the facts of weather into mutual co-ordination by recognised methods of dynamics and physics is that there are so many of them, so many elements, so many variables, so many causes of perturbation. Some meteorologists look for a general solution of the problem in the discovery of new physical laws, at present unthought of, that will make things clear. Yet, even when we revel in the proud consciousness of being familiar with all the ultimate dynamical and physical laws to which the atmosphere is subject, we may yet fail in an endeavour to relate the conditions of the moment to those of the past or to anticipate the future from the present by lack of method in the arrangement of the facts.

When we look back at the triumphs of calculation of the historic past we find always that the skilful calculator has substituted an ideal, upon which it is possible to operate, for the intractable reality. The late Lord Rayleigh made the general position clear in his first volume on "Sound," where he pointed out that in order to study sound as vibration we imagine the sounding body to be completely isolated, though, if it were so, there would be no sound. Mr. Richardson in his preface properly cites the Nautical Almanac as an alluring example of forecasting by numerical process. We are reminded of Plato's maxim, "We shall pursue astronomy with the help of problems just as we pursue geometry, but we shall let the heavenly bodies alone if it be our desire to become really acquainted with astronomy." Perhaps astronomers have been disposed to press this maxim to the extreme, yet we must admit that the Nautical Almanac owes much to the ellipse in substitution for the actual orbits of the heavenly bodies. It would perhaps be difficult to imagine anything more unreal than the latest ideal of the atom.

Hence we might argue that the first step in meteorological theory should be to group the facts in such a way as to replace the reality by a reasonable and workable ideal. That view underlies the work of Hildebrandsson and Teisserenc de Bort in "Les Bases de la météorologie dynamique," in which they

endeavoured to present the ascertained facts in a collected form in order to lead up to a working ideal, believing that premature analysis had always proved unfortunate. For two generations now the general ideal of our atmosphere has been that of a succession of travelling cyclonic vortices and anticyclonic areas. Hildebrandsson and Teisserenc de Bort provided a normal permanent circumpolar vortex in which travelling cyclones might be formed. But the ideal presented is still inexcusably vague and undeveloped: there is much to be done before we can say even what we ought to look for in a map if we wish to identify a vortex travelling under the normal conditions of the atmosphere and we are not yet ready to do justice to that ideal.

Prof. Bjerknes on the other hand has set out to prove that our maps can be simulated or stimulated by wave-motion on either side of a surface of discontinuity which separates equatorial air from polar air. Here we may note a tendency to follow another Greek maxim, this time of Aristotle, "for those things which escape the direct appreciation of our senses, we consider we have demonstrated them in a manner satisfactory to our reason when we have succeeded in making it clear that they are possible."

In "Weather Prediction by Numerical Process" Mr. Richardson follows a line of thought which differs widely from either of these. His main simplifications are to divide the atmosphere into his 16,000 slabs and to ignore perturbations which are on a smaller scale than a hundred miles. The rest is rigorous. The principle which lies at the bottom of his treatment of the subject is that the known laws of dynamics and physics as applied to the changes which take place are inexorable and are sufficient. The future can therefore be derived from the present by their application. They can be applied by the step by step method of finite differences with sufficient accuracy to obtain the general consequences of the present conditions. The illustration of the process is a most valuable contribution to meteorology and indicates a wholesome course of practical physics and dynamics of the atmosphere which may prove the basis of future teaching. Thus it will not only provide an acid test of meteorological theory but also be a valuable guide to the organisation of new meteorological observations.

Finally, perhaps the most important aspect of this contribution to meteorological literature is that a rigorous differential equation is not necessarily useless because it cannot be integrated algebraically. It opens the way to useful exercises less stupendous than calculating the weather, and indeed, whenever meteorology comes to be taught and learned, the book will be a rich quarry for the teacher and examiner.

NAPIER SHAW.

Parker and Haswell's "Zoology."

A Text-book of Zoology. By the late Prof. T. J. Parker and Prof. W. A. Haswell. In Two Volumes. Third Edition. Vol. I., pp. xl+816. Vol. II., pp. xx +714. (London: Macmillan and Co., Ltd., 1921.) 50*s*. net.

WHEN a demand arises for a new edition of a general text-book on some branch of science, the problem before the editor is to decide whether the new wine of recent discovery will go with safety into the old bottle. The solution depends largely upon the adaptability of the original scheme. When the treatment has been dominated by one aspect of the subject-matter, or when the science has entered on a new transitional phase of discovery involving new points of view, the new wine requires a new bottle.

Parker and Haswell's "Text-book of Zoology" illustrates this difficulty. Its outlook on the great and varied theme of animal life is fixed on the static anatomical aspect, on the intensive analysis of individual structure, and on the grouping of animals in classes according to structure. So fascinating and so adaptable to educational discipline is this pursuit that the anatomical aspect is only too apt to dominate other and equally important methods and aspects of animal study. It is against this over-emphasis of descriptive anatomical detail that teachers of zoology have been protesting for many years, with the result that in practice there is a more balanced consideration of the dynamical as opposed to the statical aspect of zoology.

In this respect the new "Parker and Haswell" is disappointing. The rigidity of its structure has prevented its editor from adapting the text of these two volumes to modern requirements, or from embodying more than a very small amount of the new matter and none of the new points of view that zoologists have discovered in the last twenty years. The chief revision is limited to three groups of Invertebrates—the Nematodes, Polyzoa, and Annelids—while the whole of the second volume—the Vertebrates and the philosophy of zoology—has, so far as can be readily ascertained, undergone little change.

Ungrateful as is the task of adverse criticism, it must be acknowledged that this revision has not gone far enough. In contrast to the vigorous handling of the Platyelmia and Annelids, the loose treatment of the Nematoda is very pronounced. The account of the life-history of the common Ascaris is both wrong and misleading, and the description and figure of the hook-worm are most inadequate. In fact, in regard to parasitology generally, one has but to compare the little book recently published by M. Caullery and

reviewed in this journal with the scattered references to various parasitic groups in the present text-book, to realise the inadequacy of the method to which Parker and Haswell are bound by the rigidity of their scheme. The medical and pathogenic significance of the Protozoa and the occurrence of soil-Protozoa deserve more than the passing mention given to them on p. 51, or than the reference in vol. 2, p. 617, "a terrestrial Amœba has been described." The treatment of fresh-water medusæ is also inadequate, and the structure of the common starfish (Asterias) should have been followed by an account of its development now that Dr. Gemmill's account is fully accessible. The account of the Vertebrata is in need of more fresh and vigorous handling, especially from the embryological point of view. For example, to state without comment that a bird has three pancreatic ducts, as is done here, is to miss a fine opportunity of showing the fertilising effect of embryological interpretation. In the chapter on zoological philosophy, the barest indication is given of developmental mechanics and of regeneration, but not of the new point of view raised by American work on Drosophila. The text-book remains, in fact, a useful and well-illustrated account of exemplary anatomy. What students want is a series of small monographs on special subjects. Zoology is too big a subject to be treated adequately in a single work.

Cancer and the Public.

New Growths and Cancer. By Prof. S. B. Wolbach. (Harvard Health Talks.) Pp. 53. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1922.) 4*s.* 6*d.* net.

THE lay public nowadays is very much interested in having healthy bodies, and its will to give active co-operative help to the medical profession in achieving this ideal is one of the few features of the new post-war Jerusalem that does not find itself in ruins. Medicine has ceased to be a cult of priests practising some mystery beyond the understanding of common people, and the abandonment of a professional dress means, not so much a recognition that a soft hat and tweeds are more comfortable than a tall hat and black coat, as an open expression that medical men and the lay public are fellow-workers for the common good.

How much may be attained by intelligent and interested lay folk working jointly with doctors has been illustrated lately very clearly by the disappearance of summer diarrhœa and the general decrease in infantile mortality—results, not of the direct application of assured scientific knowledge to practical life, but of the devotion of common-sense men and women in schools for mothers and similar organisations, which followed quickly enough on the conviction that it was shameful that a child should be ailing or should die. It has been said, too, that the problem of venereal diseases was solved the day that "syphilis" appeared in the headlines of a reputable daily paper. It is, indeed, clear that real progress in healthiness is as much a question of laymen as of doctors. William James says somewhere that a good deed can be perfect only if it is well received as well as well done; it is, indeed, to this co-operation of both parties that we must look for further advance.

The knowledge of "medical" matters already enjoyed by the public in general is very much greater than it was even a few years ago. It is obviously a project of high importance that it should be enlarged and extended, and this is the purpose of the "Harvard Health Talks" of which the present small volume is one. It deals with cancer and new growths, and in 53 pages presents a great deal of information. So excellent is the purpose, that it is with some regret that we find the performance disappointing. The book fails in the way that some other books of the same kind have failed. The author has not realised the abyss which separates his training and terminology from those of his audience, and has presented them with an abbreviated version of a set of lectures to professional students rather than a discourse starting from their point of view instead of from his own. With the heartiest appreciation of the intelligence of the inhabitants of Boston and Cambridge, it is difficult to believe that they will get a good start in understanding cancer from "the unit of structure of living matter is the cell" and the rest of the conventional paragraphs of dogmatic biology that form the opening chapter: it is useless as well as unnecessary to ask the educated man in the street to begin a new subject from a point of view and in a terminology which are as Greek or worse to him. The author has evidently never wondered how the man who sits next to him in the street-car would describe the facts if he knew them.

Technically, too, there is room for substantial difference of opinion. Pigmented congenital moles are certainly not universally accepted as examples of "embryonic rests," and the sentences on p. 35 attributing irritation of the bladder to the "embryos" of Bilharzia are misleading. The practical directions with which the lecture concludes are, however, admirable: do not bother about cancer being supposed to be hereditary, avoid irritations, consult a medical man at the first suspicion of anything amiss, and "never select a doctor that you would not accept as a friend."

A. E. B.

Empire Water-Power.

Water-Power in the British Empire. The Reports of the Water-Power Committee of the Conjoint Board of Scientific Societies. Pp. ix+54. (London, Bombay, and Sydney: Constable and Co., Ltd., 1922.) 3*s*. 6*d*. net.

IT is just about twelve months since reference was made to the third and final Report of the Water-Power Committee of the Conjoint Board of Scientific Societies (NATURE, December 8, 1921, p. 457). In the little book before us the whole of the results of the investigations made by the committee, as set forth in the three successive reports, are embodied. This compact statement of the present position of the British Empire in regard to the development of its water-power resources will be welcome to all who are interested in the matter, either from a purely scientific or from a utilitarian and practical point of view. It represents the outcome of four years of valuable research work, carried on with unremitting activity by the committee under the capable direction of the chairman, Sir Dugald Clerk, and with the energetic and painstaking assistance of the secretary, Prof. A. H. Gibson.

Sir Dugald Clerk contributes to the volume a preface of a very thoughtful and stimulating character. He tells us that the 46 million people now living in the United Kingdom require an expenditure of energy of 10½ million horse-power for their support, and that while this supply of power is undoubtedly forthcoming, for the present, from our stock of coal, yet our reserves of natural fuel are bound to diminish, and in time to be depleted, so that we shall be obliged to fall back upon other agencies to make good the deficit. Taking the United Kingdom as a whole, there appears to be continuously available (24 hour period) a total of 1,350,000 horse-power, or if any great tidal scheme, such as that of the Severn, be included, perhaps a total of 1,750,000 horse-power. This is, of course, insufficient to replace the work done by means of coal-fired engines, but, at least, it would represent a very substantial saving in fuel.

On the other hand, this power is not all economically realisable, or rather the cost of obtaining the whole of it would be higher than is justified, as yet. In Scotland, however, some 183,000 horse-power is immediately feasible, at a cost appreciably less than that of coal-fired stations built and operated under existing conditions. Even in England and Wales, a large proportion of the quota is commercially obtainable. It is obviously a matter, then, of national concern to devise means for making use of these natural power supplies, which are running to waste, if only for the purpose of supplementing the work which is at present done by our far from inexhaustible supplies of coal.

The report covers a wider field than Great Britain; it embraces the resources throughout the British Dominions, and its carefully compiled figures will be of considerable assistance to those whose interest lies in the promotion of water-power schemes at home or abroad.

BRYSSON CUNNINGHAM.

Our Bookshelf.

Modern Electrical Theory. Supplementary Chapters. Chapter XV.: Series Spectra. By Dr. N. R. Campbell. (Cambridge Physical Series.) Pp. viii+110. (Cambridge: At the University Press, 1921.) 10*s*. 6*d*. net.

THE work now before us is one of the supplementary chapters to Dr. Campbell's book on modern electrical theory. This series of supplements is planned according to an idea which might well be used by the authors of other text-books on physics. It is unfortunate, however, that we are unable to commend the present book to those who, like the reviewer, welcomed the author's original work as a real and vital account of the subject. The book contains numerous errors which any practical spectroscopist would detect at once; and they reach their culminating point when the author, in a professedly complete list of the chemical elements the spectra of which form well-defined series, omits oxygen, sulphur, and selenium. The spectrum of oxygen is, almost in a classical sense, one of the most beautiful and ideal series arrangements known to every spectroscopist. It has not played a part in the application of the quantum theory as yet, which may provide the explanation of the circumstance that the author is unaware of this fact, as he shows more than once.

The genesis of this book is quite clear. The author has read Bohr's recent work on the "Correspondence Principle," and, like every other reader, has been very much attracted by it. He has also consulted all the Danish and German writings, and he gives a really excellent account of them in a very non-technical style. Dr. Campbell appears, however, to be unaware of the contribution of this country to the subject, and of the practical details of spectra. The second deficiency explains why all the facts of spectra which he gives correctly are those which foreign writers have quoted in support of the quantum theory. Following the usual assumption that all the significant work on the subject has been done abroad, anything written in English is mostly ignored or misquoted. It is difficult, indeed, to find an English name in the whole work. A treatise on any branch of this subject which never refers to the fundamental work of Jeans, dismisses that of Fowler with a casual mention of his least important contribution, credits Nicholson with a mere suggestion that the angular momentum in an atom might have discrete values, and finally never mentions W. Wilson, who anticipated Sommerfeld in the fundamental generalisation, while putting it on a

real dynamical basis, as Sommerfeld himself has admitted in his latest edition, excites both surprise and regret. Except from one point of view, the work is misleading and inaccurate in detail. What it does give is a condensed summary of foreign work, which is excellent if read at the same time as a compendium of the actual experimental facts of spectra.

Air Ministry: Meteorological Office. The Weather Map. An Introduction to Modern Meteorology. By Sir Napier Shaw. Fifth issue (reprint of fourth). (M.O. 225*i*.) Pp. 109 + 8 plates + 8 charts. (London: H.M. Stationery Office, 1921.) 1*s*. 3*d*. net.

IT is not possible to overestimate the high value of this work. At the present time the demand for weather knowledge is very keen, the enthusiasm being stimulated by the wireless broadcasting of weather information. To appreciate fully the information received by wireless it is essential to be able to grip intelligently the scientific details involved. The work under review contains much general information on meteorology. The former edition was issued four years ago, and the earlier copies gave much assistance in the training of meteorological units in the army, so essential for many interests during the war.

The publication contains specimen weather maps, and the letterpress thoroughly explains their construction and the results which the maps provide. Weather systems and their movements are dealt with and explanations are given of the sequence of weather, the travel of the centres of disturbances, and the veering and backing of the wind. Recent research relative to the upper air is incorporated, and a thorough understanding can be secured of the distribution over the British Isles of cloud and rain consequent on the passage of a storm area across the country. Information is given as to averages and normals, and the numerous tables, diagrams, and maps in the latter half of the book are useful for reference. The cost of the earlier editions of the work was 4*d*., but the charge, 1*s*. 3*d*., for the present issue is exceedingly small, and the work should be obtained by all who would be meteorologists. C. H.

Rocks and their Origins. By Prof. Grenville A. J. Cole. (Cambridge Manuals of Science and Literature.) Second edition. Pp. viii+175. (Cambridge: At the University Press, 1922.) 4*s*. net.

IT speaks well for the discrimination of the readers of popular science that a new issue of this thoughtful introduction to the study of rocks should be called for. Prof. Cole is equally at home in tracing the history of the development of scientific theories and in describing the relation of scenery to the geological structures of the rocks that underlie it. He discusses without too much technical detail the origin of the different types of rocks of which the earth's crust is composed, and gives a very fair résumé of the controversies which have been waged on the subject, many of which are still as active as ever. There are a number of happily chosen illustrations of rock scenery, mostly reproduced from the author's own photographs. This little volume is honourably distinguished from others of a similar character by the clearness of its style and the abundant references which will prove useful in directing the student's attention to scientific contributions that he might otherwise overlook. There are few of our geologists who have read so widely and to such good effect as Prof. Cole. J. W. E.

Farm Book-Keeping: The Principles and Practice of Book-Keeping applied to Agriculture: for Agricultural Colleges, Extension Classes, Evening Classes, and Practical Farmers. By John Kirkwood. Pp. 224. (Edinburgh: W. Green and Son, Ltd., 1922.) 6*s*. net.

ONE of the most noteworthy developments in the study of agriculture is the attention which is now paid to the economic aspects of farm working. Mr. Kirkwood's book (one of the Scottish Series of Junior Agricultural Text-books) is to be welcomed as a work which contributes to this development.

Part I. consists of nineteen concise chapters dealing with double-entry book-keeping in its application to farm management. Part II. sets forth a simple cash-book system for the benefit of those who may regard double-entry as a complicated system, and the author assures us that his simplified method of keeping accounts has stood the test of actual use.

With practical handbooks of this kind on the market there can be no excuse for the repetition of those blunders in farm management which are the accompaniment of a disregard for scientific study and a blind adherence to tradition.

Coal-tar Colours in the Decorative Industries. By A. Clarke. Pp. xiii+166. (London: Constable and Co., Ltd., 1922.) 6*s*.

THE uses of coal-tar dyestuffs in lake-making, and in leather, fur, wood, paper, etc., colouring—*i.e.* those applications which are not covered in the ordinary treatises on fabric dyeing—are considered in Mr. Clarke's work. The treatment is, naturally, wholly technical, and very brief. A bibliography is given. To the expert the treatment will doubtless appeal, but to the ordinary scientific reader such sentences as the following indicate a language even more formidable than his own: "The level-dyeing acid dyestuffs do not exhaust well, but if they are topped with basic colours the backwaters are colourless." A glossary might have been added for the uninitiated.

The Peoples of Europe. By Prof. H. J. Fleure. Pp. 110. (London: Oxford University Press, 1922.) 2s. 6d. net.

IT was no mean task to attempt an adequate sketch of European peoples in about a hundred pages, but Prof. Fleure has been fairly successful. His volume is opportune at a time when a sound scientific basis for the discussion of the complex problems of Europe is essential, and it is a happy illustration of the value of a geographical foundation in the study of political problems. The book contains not only a great amount of information but also a wealth of ideas, and is a genuine contribution to the vexed questions of the time. There are three sketch maps and a short but useful bibliography. The lack of an index is unfortunate.

R. N. R. B.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Spectrum of the Night Sky.

I HAVE now succeeded in obtaining a spectrogram showing the general features of the spectrum of the night sky in the south of England, with the moon below the horizon. The exposure given was about 50 hours, beginning each night not earlier than 2½ hours after sunset, and closing about midnight. There appears, therefore, to be no possibility that sunlight or moonlight intervened.

The spectrum shows the bright yellow-green aurora line very strongly. There is a continuous spectrum corresponding in distribution to the solar spectrum, and showing the dark Fraunhofer lines H and K. These are perfectly definite. The exposure is not enough to show the other Fraunhofer lines definitely, and, in any case, the instrument used is only capable of showing a few of the strongest of them.

There is no trace on this plate of the nitrogen bands, which form so conspicuous a part of the spectrum of the polar aurora. From some exposures I have made in the neighbourhood of Newcastle, three degrees farther north, I believe that the negative bands of nitrogen are a normal feature of the night-sky spectrum there. But more work is required on this point. RAYLEIGH.

Terling Place, Witham, Essex.
November 25.

Medical Education.

IT is stated in NATURE (November 18, p. 683) that "The professional course has grown so full in the training of a medical student that it has become increasingly difficult to cover the ground and secure qualification in a reasonable time." It seems that chemistry and physics are to be placed outside the professional curriculum, but biology is to be retained. A knowledge of chemistry and physics is necessary to the doctor; and much of the recent advance in both medicine and surgery is due to discovery in these sciences. But can any one tell us of what utility, practical or intellectual, is the biology which medical students learn—facts about the classification of plants, the vascular system of the sea-urchin, the digestive system of the leech, the bones in the cod's head, and so on? No one is a better physician or surgeon for such knowledge; and, therefore, since it has no bearing on later study and practice, it is forgotten as soon as the prescribed examinations are passed.

For the medical man the intellectual value of biology should lie, if anywhere, in interpretation. It should cause him to think. He should learn man's place in Nature—how he resembles and differs from other living beings, and how these likenesses and differences arose. Man is in body and mind above all the educable, the trainable, the adaptive being. From birth forwards he develops mainly in response to use. He is rational and intellectual because his mind grows through functional activity. That is his special distinction; that places him in Nature. The medical student learns nothing of all this. He may be taught, incidentally as it were, that some characters are inborn, or acquired, or inheritable. But a year or so later, physiologists and pathologists tell him the quite indisputable truth that every character takes origin in germinal potentiality (predisposition, diathesis), and arises in response to some sort of nurture—*i.e.* that every character is equally innate, acquired, and inheritable. If the student thinks at all, he must conclude, as Prof. Armstrong says very truly in another connexion (NATURE November 11, p. 648), "We are mouldering away in our laboratories and when we seek to make known what we have been doing we use a jargon which we cannot ourselves understand."

The medical student may be told that Natural Selection is an interesting speculation, but that no man has seen it in operation. Again, if he thinks, he will conclude that, owing to defective opportunities for observation, no man *could* see Natural Selection in operation among the wild animals and plants which biologists study. Nevertheless, a year or two later he will perceive it in full swing in the case of tuberculosis and every other lethal and prevalent human disease, and will learn that every human race is resistant to every human disease precisely in proportion to the length and severity of its past experience of that disease. There are scores of diseases and hundreds of races and sub-races of mankind; and, therefore, in some thousands of instances—whenever and wherever close observation is possible—he will find Natural Selection causing adaptive evolution. Moreover, he will learn that just as human races alter gradually in powers of resistance, so, at the other end of the scale, bacterial races alter in virulence when removed from one kind of animal to another, a thing quite inexplicable except on grounds of Natural Selection.

The student may be taught that effective selection occurs among mutations, not fluctuations. A year or so later he will perceive tuberculosis selecting amid all shades of difference, with the result that races present all shades of evolution. He may be taught that mutations segregate and that their inheritance is alternate. A year or so later he will learn that human mutations (*e.g.* idiocy, hare-lip, club-foot) are inherited, perhaps for many generations, in a patent or latent condition, and that only their reproduction is alternate. Moreover, he will wonder, if mutations segregate, how it happens that long-lost ancestral traits sometimes reappear in *purely bred* domesticated varieties (*e.g.* pigeon, poultry, and many plants). He may be taught that evolution depends on mutations and that mutations do not blend. A year or two later he will learn that human races never differentiate while there is inter-breeding, but diverge rapidly and infallibly when separated by time and space; that, though men are fond of telling about wonders, yet in the whole of written human history (4000 years or more) no useful human mutation has been recorded, nor one that changed the type of a race; that all human varieties (*e.g.* negro and white), like all natural varieties (*e g.* brown and polar bear), blend perfectly when crossed in all characters except those linked with sex; and, lastly, that "lost" ancestral traits never reappear except when one of the parties to the cross is derived from a domesticated variety. If he thinks at all, he will conclude that Natural Selection is founded on fluctuations, but that man, as Darwin noted, "often begins his selection by some half-monstrous form, or at least by some modification prominent enough to catch the eye or to be plainly useful to him." He may be taught that the doctrine of recapitulation is doubtful. But if he thinks at all, he will perceive that any other mode of evolution and development is totally inconceivable. And so on.

The point I wish to emphasise is that medical men, with an acquaintance with man infinitely more

intimate than any biologist can have with any animals or plants, with abundance of direct, not merely circumstantial evidence, have no need for the traditional biology of biological teachers. They are in a position to construct, and for all practical purposes have already constructed, a biology of their own. The traditional teaching has with them no influence whatever except as a waste of time, and ought to be, and before long is sure to be, eliminated from a curriculum which has outgrown it.

G. ARCHDALL REID.

9 Victoria Road South, Southsea,
November 19.

Divided Composite Eyes.

IT is not uncommon to find among insects instances where each composite eye is divided into two portions, so that in appearance there seem to be four eyes instead of two. In sections, however, it is seen that both parts are connected with the same ganglion.

Sometimes the reason for the division is obvious, as in the case of certain beetles which have a prominent sort of "armoured belt" carried horizontally round the head. Here half the eye is above and half below the belt, thus giving a view of the ground as well as of objects above it.

The reason for duplication, however, is not always so apparent. In the majority of composite eyes the convex surface is covered with lenses of uniform size, but in those to which the present note relates, namely, dragon-flies, White (or Cabbage) fly, and Aphides, this is not the case.

Among the dragon-flies—a very highly developed type—each eye presents a continuous convex surface, but the lenses of the upper part are much larger than those below. The transition from large to small is quite abrupt, but as the curvature of the surface is continuous the line of demarcation is not noticeable without the use of a magnifying glass.

In the White-fly (*Aleyrodes proletella*, etc.), where the eyes are well divided, the relative position of the large and small lenses is reversed, the large lenses being below.

The eyes of Aphides present for the greater part of their area a convex surface carrying lenses of equal diameter, but not far from the posterior margin there is a small prominence bearing a few lenses on its summit and sides.

The appearance of the eyes of dragon-flies is so well known that it is scarcely necessary to give figures, but it may be remarked that the areas covered respectively by the large and small lenses differ considerably both in form and extent in different genera.

White-fly is chiefly known as a pest in greenhouses, and until its appearance in unusual numbers in the autumn of 1921, I had never given it any attention. Any one, however, who examined the perfect insect with a magnifying glass might well be excused for taking it (as did Linnæus) for a small moth, but if the course of its development is followed up from the egg to the imago it is seen to be more nearly allied to the Aphides.

Far the best account of it is given by Reaumur ("Memoires," Tome II.) in 1736, and having myself repeated his observations of its transformations, I can confirm the accuracy of his description. All Reaumur's specimens were apparently taken from the leaves of *Chelidonium majus*, but this plant is not abundant in the neighbourhood of Exeter. White-fly, however, feeds on a great variety of leaves, and I have taken it from cabbage, cucumber, tomato, campanula, veronica, and from many composites. There is a considerable difference in these cases both in the size of the perfect insects and in the density of the cottony down with which they are coated, which gives them their white appearance, but whether this implies real specific differences or is only a result of different food, is, I believe, considered uncertain. Among my own specimens, those taken from cucumber were the smallest in size and had the thinnest coating of down. The divided eyes were closely similar in all, and the general appearance of the insect is shown in the camera-lucida sketches, Fig. 1. When the head is viewed from underneath, especially when it is so turned that only the lower pair of eyes are visible, the face is curiously owl-like, the proboscis standing for the beak.

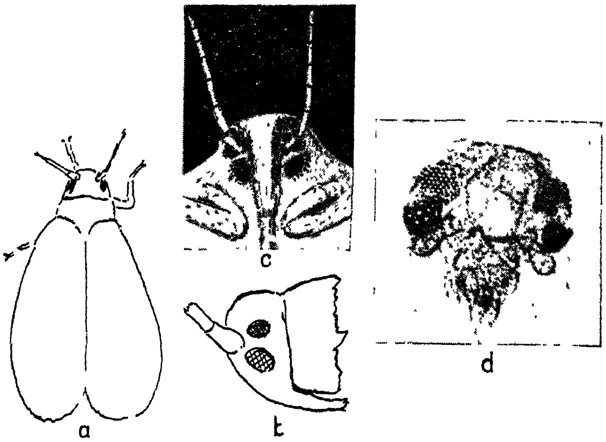

FIG. 1.—Aleyrodes.

a, Camera-lucida sketch of *A. proletellæ* × 25.
b, Head, side view.
c, Head, from below.
d, Head × 125 (60 in the reproduction), front view to show the difference in the size of the lenses in the two divisions of the eye. The contents of the head and the exterior down have been removed. The specimen was taken from cucumber. Diameter of upper lenses 0·0003 in., of lower lenses 0·0005 in.

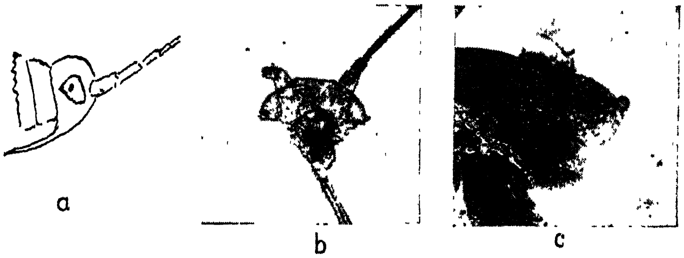

FIG. 2.—Black Aphis taken from Laburnum.

a, Head, side view.
b, Head, front view × 50.
c, Eye and part of head × 125 (60 in the reproduction), seen from above.

The eyes are shown in more detail in the photograph, Fig. 1.

There is always some difficulty in photographing such objects as require large magnification, but the structure of which does not permit of these being flattened; and though much less detail is shown in Fig. 1 *c* than can be made out by focussing each part independently, the difference in the size of the upper and lower groups of lenses is very apparent.

Several species of Aphis taken from various plants were examined, and in all of them the eyes had the

peculiar feature illustrated in Fig. 2, *a*, *b*, and *c*. The prominence varied slightly in size and position in the different species, but there was always at least one lens on the summit and three or four round the sides.

Divided eyes must be, or at some period have been, of use to their possessors. Have the naturalists any explanation of what that use is? The case of the Aphis eyes seems especially difficult.

In the last century Johannes Muller expressed the opinion that in the picture formed by a composite eye each lens contributed only one impression, *e.g.* that the picture was made up of only the same number of patches of light and shade as there were lenses to form them, just as in the modern "process block" light and shade effects are produced by the varying intensities of uniformly distributed dots.

In 1894 I gave (Proc. R.S.) some theoretical reasons in support of Muller's view. This paper has been mentioned in several more recent books, but the theory itself is not quoted. It is, however, so simple and, coupled with the measurements of various composite eyes, so conclusive that it may be worth repetition in this place.

Every one knows, or ought to know, that the image formed by a perfect lens of a distant bright point consists of a bright disc surrounded by faint rings, and that the angular diameter of the disc as seen from the optic centre of the lens is of the order λ/D, λ and D being respectively the wave-length of the light and the diameter of the lens. This being the case, it is evident that no advantage in definition will be gained by providing a retina capable of distinguishing angular distances less than λ/D, *i.e.* the least distance which the lens can resolve.

If the wave-length is taken as 1/50000 of an inch, then for a lens 0·001 in. in diameter λ/D is rather more than one degree, and for a diameter of 0·0001 in., rather more than ten degrees.

If a number of small lenses are placed side by side with their edges touching on the surface of a sphere of radius R, and if the focal length of the lenses is small compared to this radius, images of outside objects will be formed on a concentric spherical surface (with a radius somewhat less than R); in these images, only those objects can be separated of which the angular distance apart is greater than λ/D.

If, then, the focal surface is covered by a retina which provides only one sensitive point for each lens to act on, the maximum definition will be secured if the subtense of each lens at the centre of the sphere is also λ/D, that is if $D/R = \lambda/D$, and this is the relation found to hold in the most highly developed composite eyes. It may be said, therefore, that the construction of these eyes is one of the most definite references to the wave-length of light to be found in organic structures. The actual values of D lie between something over 0·001 in. and a little less than 0·0003 in.[1] The definition, therefore, even in the most favourable cases, is very poor compared with that given by the simple eyes of vertebrates, where a single lens forms an image on a retina closely packed with sensitive points, while in the composite eye each retinal point is capped with its own lens.

To form a composite eye with the same defining power as the human eye, for example, the lenses would have to lie on a spherical surface of 18 ft. radius.

It would be interesting to know how or why the two types have come into existence. A. MALLOCK.

9 Baring Crescent, Exeter, November 7.

[1] I have taken some trouble in arriving at this lower limit, measuring directly for this purpose the values of D for the smallest Diptera (and their parasitic Hymenoptera), Ephemera, and others.

Action of Cutting Tools.

IF Mr. Mallock's friction theory of cutting-tool action is valid, and if cutting tools are ever effectively lubricated, it would follow that the dry tool should have an angle different from that of the lubricated tool. But this is contrary to universal practice. The inference would then be that either the friction theory is unimportant and extremely incomplete, or that lubrication as practised by engineers is very ineffective. The latter view seems more correct, for the following reasons.

When a tool has been cutting for some time, metal accumulates on the point of the tool and adheres sometimes so firmly that it cannot be removed, without risk of breaking the tool, except by grinding. This agglomeration of metal may be said without looseness to be welded to the tool just as in cases of bearing seizure the metals are welded together. This is especially obvious in heavy work, and it can be seen in a lesser degree in moderately light work. When contact is so intimate and pressure so great as to cause such cohesion it is difficult to conceive that lubrication in the usual sense of the term can exist at the point of a cutting tool.

Moreover, engineers in many countries have striven to introduce lubricant to the cutting face by means of high-velocity jets and by drilling holes in the nose of the tools, but without success.

Lastly, the temperature at the tool face is extremely high. Turnings which pass over the surface are hot enough to cause serious burns, and large tool cross-sections are necessary to conduct the heat away from the nose of the tool. It has been observed that modern high-speed steel will cut at a dull red heat; and while this is an abnormal condition, there is evidence enough to show that the temperatures existing in average machining work are higher than can be met by special lubricating systems under less strenuous pressures. These considerations seem sufficient to rebut the idea of cutting-tool lubrication in most cases, and to suggest that the chief value of so-called cutting oils is in their cooling properties. Even turpentine, which is useful in cutting hard steel, may have much of its value in its latent heat of evaporation. Certainly to obtain a good finish on hard steel with turpentine often requires a spring tool and light cuts, in which case there is the equivalent of chatter in a mild form, and this is conducive to lubrication.

In the discussion on Prof. Coker's paper it was stated that the point of the tool was not in contact with the work, and Dr. Lanchester very trenchantly asked, What was the good of having the tool sharpened? But it is well known on heavy work or with tools of inferior temper that work must be stopped periodically and tools reground. The idea that the point of a tool is not in contact with the job is perhaps a natural one, and rests on a difficulty hitherto unexplained. It is common observation that a tool wears most some little distance from the edge, and the edge may last a good deal longer than the part behind it. But this is no proof that the edge is not in contact; and if the edge were not in contact, the action of cutting tools would be even more perplexing than it is.

The explanation of this point may lie in the fact that the turning has less relative motion near the edge of the tool than at some distance behind, and the justification for this view is seen in a closer examination of the motion of a turning. The neutral axis of a turning has a constant speed approximately equal to the cutting speed, but when the turning begins to bend there is a speed of rotation added to the speed of the neutral axis, and this rotational

speed varies as the thickness of the turning. As the turning does not begin to curl or bend until after it passes the edge, it is not difficult to see why the edge should wear well and give the impression that it had not been in contact. The fact that the point of the tool is in contact with the work may be inferred from the fact that in many circumstances steel is welded on to the point, and but for the greater relative motion behind the cutting edge where the scouring action is excessive, this deposition of metal would probably be more extensive.

We are then driven back on another part of the problem. Why do shavings curl? The analogy with rivet heads is unconvincing, for shavings are universally flat in a lateral direction, which—having regard to variety of tool profiles—is evidence of the extraordinary stresses involved and of the flow they produce—the stress on the upper face of the tool is of the order of 100 tons per square inch in quite ordinary practice. A more direct and convincing explanation is the following. Consider a piece of the shaving as in the diagram (Fig. 1). There is the downwards shearing force S at the principal plane of shear and an opposite reaction R at the tool face. These produce a turning couple which has more than one effect. In most cases the effect of this couple is

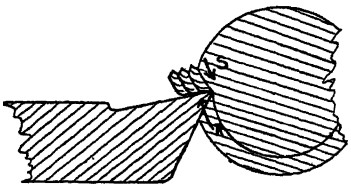

FIG. 1.

to distort the emerging element into a wedge the base of which is extended by plastic flow at the tool face and the upper part is shortened as in bending. The tendency is to place the lower or bearing surface of the shaving in tension as in a beam, and if the material has a low tensile strength as in cast iron, the shavings break, but even these brittle materials show a slight curl in the small particles removed by the tool. Friction at the tool face, as Mr. Mallock points out, resists curling, but it is probably not the governing factor. In the discussion on Prof. Coker's paper, Mr. H. I. Brackenbury put forward the very important observation that slow speeds are conducive to curling and high speeds produce straight shavings —this in tough steel. Having regard to the fact that cutting-tool action is a problem in plastic flow, the viscosity of the metal is probably important; and as the temperatures at the moment of cutting are very high, conductivity and tensile strength when hot may be decisive factors. The ratio of shearing strength to tensile strength enters into the phenomenon of curling, but as parts of the shaving are flowing it is not easy to get clear views on what is taking place.

H. S. ROWELL,
Director of Research.
Research Association of British Motor and Allied Manufacturers.
15 Bolton Road, Chiswick, W.4.
November 9.

An Empire Patent.

MR. HULME's letter in NATURE of November 11, p. 633, raises objections to the Empire Patent on grounds which would occupy too much space to traverse fully, but I would venture to question his general condemnation of the present patent system. A system such as he proposes, which would grant a monopoly only to such persons as were actually working an invention, would be unjust to an inventor without capital to exploit his ideas. Moreover, considerations of novelty could not entirely be left out. Presumably Mr. Hulme would leave this to be decided by the Courts; but litigation is costly, and I imagine that few concerned with the business side of patents would be willing to dispense with a search for novelty on the part of the Patent Office, the advantages of which appear to be sufficiently obvious. The limitation, for practical reasons, to British patent specifications does not detract from those advantages, for, assuming the patent system to be of some value, it is most likely that subject-matter of a patentable nature will be disclosed in the first place in a patent specification. Mr. Hulme's objections to the search appear to be based largely upon United States experience, but the opinion he quotes may be due to difference of efficiency in administration in the two countries, particularly when we consider that American search is theoretically not so limited as here.

The arrangements as to "working" laid down in the Patent Act of 1919, which ensure that any patent granted in this country must be worked here on a commercial scale, would, it is to be presumed, apply to an Empire Patent.

In conclusion, may I be allowed a word of warning on the too facile application of biological considerations to human society? Mr. Hulme's assumption that a flattening of the population curve is an unfavourable symptom would not be endorsed by sociologists, and tends to discount whatever force there may be in his biological deductions *re* Patent Laws.

ERNEST E. TOWLER.
35 St. Andrews Square,
Surbiton, November 15.

The Movement of the Positive After-image.

THERE is no doubt that movement of the positive after-image takes place without movement of the eyes as Mr. H. S. Ryland states (NATURE, November 18, p. 668). His experiment is complicated by the fact that all portions of the light shown have not the same intensity, causing a corresponding difference in the after-image.

There appears to be, at any rate while the eyes are being used, a steady circulation of photo-chemical material from the periphery to the centre of the retina. The following experiment shows very simply the movement of the positive after-image without moving the eyes. If two rectangular strips of white paper about three inches long and a third of an inch wide be placed on a piece of black velvet and separated by a distance of an inch, definite positive after-images may be obtained of the two strips by viewing them with one eye, the eye being directed to a point midway between the two strips of paper, the other being closed and covered with black velvet, for the shortest possible time, the eye being simply opened and closed. Two clear-cut positive after-images will first be seen; these rapidly become blurred and gradually approach each other, the central portions of each appearing to bulge towards each other and to combine first; the upper and lower portions disappear first, the two after-images gradually combine in the centre of the field of vision, the last phase being a white circular blur, which slowly disappears with a whirlpool movement. It will be noticed that the after-images do not become negative.

F. W. EDRIDGE-GREEN.
London, November 18.

Acoustic Research.

THE editorial article on the subject of "Acoustic Research," in NATURE of October 28, p. 565, conveys an impression which seems to need correction.

In justice to the life-long labours of the late Prof. W. C. Sabine, now gathered into a volume of "Collected Papers on Acoustics" (Harvard University Press), it should be said that the practical problem of predicting the acoustics of an ordinary auditorium in advance of its construction, or of correcting one already built, was solved by Prof. Sabine some twenty years ago. The essential feature to be considered in such a problem is the reverberation, and Sabine's papers on this subject are full and complete. Other acoustic questions are, of course, sometimes involved, such as the transmission of sound through walls, the effect of resonance, etc. Several of these had also been the subject of prolonged experimental investigation by Prof. Sabine at the Jefferson Physical Laboratory at Harvard, but some of the results were withheld until the work could be completed. His untimely death interrupted this programme, and since then the work has been continued here, and at the Acoustical Laboratories, Illinois, under the direction of Dr. Paul E. Sabine, as described in Mr. Munby's article in the issue of NATURE of October 28, p. 575.

Architects in the United States have become aware of the importance of Sabine's results, and scores of cases could be cited in which the application of the principles worked out by him has led to complete success. The opinion that "the laws regulating the production of a successful building for hearing and speaking have yet to be worked out" implies a lack of respect for Sabine's profoundly accurate and thorough work, which I am sure no one will maintain who has taken the trouble to acquaint himself with the subject.

THEODORE LYMAN.

Harvard University, Cambridge, Mass.,
November 14.

[The intention of the article to which Prof. Lyman refers was to promote increased attention to acoustic research; and we regret that a phrase in it should be regarded by him as implying a lack of respect for the pioneer work done by the late Prof. Sabine. While readily admitting the value and completeness of Prof. Sabine's papers, the continued useful activities of his acoustic laboratory would seem to indicate that in the general sense intended the expression used in reference to the need for further investigation was justified. It may be true that rules have been worked out upon which a perfect acoustic building can be constructed; the practical problem presented to the architect, however, often takes the form of the provision of acoustic success with prescribed limitation in the matter of design, and it is in this direction that further knowledge is needed.—EDITOR, NATURE.]

Separation of the Isotopes of Zinc.

PURE zinc has been subjected to distillation in a high vacuum, and after three fractionations of the distillate the latter shows a lower density than the original zinc. The residue has been reduced by evaporation to one-twentieth of the original volume and shows an increased density. The method of separation is similar in principle to that of Brønsted and Hevesy for mercury.

Two sets of distillations have been carried out. In the preliminary set, last winter, the distillations of the distillate were carried out too rapidly and too great a quantity was distilled. The results for the distillate indicated no separation, whereas the separation of the residue, which was effected under better conditions, showed an increase in density. Another set of distillations was therefore carried out this summer under improved conditions (using liquid air condensation and a more careful regulation of the temperature and the quantity distilled). The final distillate is lighter and the final residue heavier than the original zinc. The determination of the density of a metal, as ordinarily performed, is no criterion of the average atomic mass per unit volume. The main part of the work has therefore been directed towards making it so; the only alternative appears to be the determination of the atomic weight to an accuracy of about 1 part in 10,000. The presence of flaws, of impurities, of allotropes, and of metal in a different physical state do not sufficiently explain the results; the discussion of these four points will be included in the publication of the work.

Taking the density of the initial zinc as unity, the density of the distillate is 0·99971, and of the residue 1·00026. These numbers appear to be outside the error of 14 determinations of the density of 7 separate samples of the initial material, for the greatest divergence between the numbers obtained only amounts to 0·00015. On recasting the residue and the distillate the difference is maintained.

The separation indicated by these figures would imply a change in atomic weight of about $3\frac{1}{2}$ units in the second place in the atomic weight. This is considerably less than might have been expected if the metal was composed of equal quantities of an isotope of an atomic weight of 64 on one hand, and of isotopes 66, 68, and 70 on the other hand.

ALFRED C. EGERTON.

The Clarendon Laboratory, Oxford,
November 21.

A Curious Feature in the Hardness of Metals.

BY combining Meyer's formula

$$L = ad^n$$

with that for the ordinary Brinell test

$$H = L \div \frac{\pi D}{2}\left(D - \sqrt{D^2 - d^2}\right)$$

the following relationship is obtained:

$$H = \frac{2}{\pi D} \cdot a^{\frac{2}{n}} \cdot L^{\left(1-\frac{2}{n}\right)}\left\{D + \sqrt{D^2 - \left(\frac{L}{a}\right)^{\frac{2}{n}}}\right\}.$$

In this the second term ceases to have a real meaning when

$$D = \left(\frac{L}{a}\right)^{\frac{1}{n}}.$$

Beyond the load corresponding to a value

$$L = aD^n$$

the hardness becomes imaginary, or, in other words, the load will be sufficient to force the ball through the material continuously. This fact may well be of considerable importance in connexion with such questions as the penetration of a plate by a projectile, in punching operations, and even in lathe work.

In the case of a steel of 0·2 per cent. carbon and 0·6 per cent. manganese with a Brinell hardness number of 140, using a ball of 10 mm. diameter, and a load of 3000 kilograms, the values of a and n will be about 74 and 2·29 respectively. Under these conditions the load at which perforation of the steel will occur will be 14,400 kilograms, when the hardness will have fallen to 92.

Further work in this direction is being carried out by one of us; but the fact that there is a high load at which the ordinary hardness measurements cease to apply, and the possible significance of the fact, seemed sufficiently interesting to warrant early publication.

HUGH O'NEILL.
F. C. THOMPSON.

The Victoria University of Manchester,
November 15.

The Use of a Pancreatic Extract in Diabetes.[1]

By Sir C. S. SHERRINGTON, G.B.E., P.R.S.

IN the words of its charter, repeated at the admission of each new fellow, the Royal Society is described as instituted "for Improving Natural Knowledge." A main means for that "improving" is discovery. In the case of natural knowledge the main road to discovery must lie in research. There are several ways in which research can be encouraged, and one of them lies in providing suitable workers with the means to devote their time freely to investigation. The society is fortunate in possessing now, to a somewhat greater extent than formerly, funds that may be considered as permanently allocated to this fundamental object; for though its existence extends now to more than two and a half centuries, financial help directed to this eminently important aim has come only relatively recently. That it should have now begun may be a sign of the arrival of an Age in some respects new; the beginning of a trend towards wider public interest in and sympathy with research.

Of events in biological science in the past year I may mention one that is attracting attention at this time. In the Physiological Laboratory of Toronto University has been prepared a pancreatic extract possessing striking power over the carbohydrate metabolism of the body. Potent as it is, experience with it is still limited. Work of urgency is required with what may prove to be a desired remedy; the first programme is further investigation of the extract's full properties, with caution as to raising hopes which practice may but partly fulfil. Such are the considerations which weigh with the Canadian—and the discovery is from a Canadian university—to whom the discovery is due. In this country the Medical Research Council has undertaken public-spirited direction of the extract's preparation and of further determination of its properties.

The physiological steps of the discovery may be briefly outlined thus:—Destruction of the pancreas is well known to produce in the dog a diabetes-like condition, rapidly fatal. The liver's store of glycogen is lost, and cannot be renewed by even liberal supply of its normal source, carbohydrate food. Sugar formation from proteins ensues, with rapid wasting of the tissues; at the same time the blood is surcharged with sugar, and the tissues are unable to make use of sugar. In a normal animal, glucose put into the circulation raises the ratio of carbon dioxide expired to oxygen absorbed, because the tissues consume the sugar. But glucose similarly introduced into the depancreated diabeticanimal does not raise the respiratory quotient; the tissues no longer consume the sugar. The inference has long been that the pancreas produces some substance enabling the body to make use of sugar—some substance that in fact should control certain forms of diabetes. At Toronto there seems to have been secured the extraction of that substance.

The pancreas consists of two structures intimately commingled. One, secreting cells set round ducts into which they pour the pancreatic juice, is potently digestive: the other, scattered in tiny islets, is seemingly unrelated to the ducts though closely related to the blood channels. The want of success of pancreatic extracts in mitigating a diabetic condition might be due to digestive powers of the juice cells destroying an anti-diabetic substance of the islet-cells. Dr. F. G. Banting determined to avoid this possibility by preparing extracts made from the pancreas after its trypsin-yielding cells had been selectively brought to atrophy by ligation of the gland ducts. He and Mr. Best, a collaborator who joined him, overcoming formidable difficulties of technique, succeeded in preparing the required material, and in examining the effect of extract upon diabetic depancreated dogs. They found the sugar fall both in the blood and urine, and that the animals, instead of dying in three weeks, remained, while treated, in excellent condition.

The further prosecution of the work afterwards engaged other collaborators: to mention them in alphabetical order, Collip, Hepburn, Latchford, MacLeod, and Noble; of these Prof. MacLeod, himself director of the Toronto Physiological Laboratory, is well known as a skilled authority in experiments on carbohydrate metabolism, and Dr. Collip is professor of bio-chemistry in the University of Alberta, though temporarily working at Toronto. With team work, advance has proceeded relatively quickly, and successful extracts are now obtained from ordinary ox and other pancreas.

Of much physiological interest is the fact that the active principle in the extract seems one *normally* controlling the blood-sugar in health, for its injection rapidly lessens the blood-sugar in normal animals. The extract, added to a simple perfusion fluid containing a little glucose and streamed through the isolated rabbit heart, increases three- or fourfold the heart's uptake of sugar from the fluid. The extract sometimes evokes serious nervous disturbances seemingly associated with extreme fall in the amount of the blood-sugar.

Administered to diabetic depancreated animals, the extract brings reappearance of the liver's glycogen store, while bringing down the sugar excess in the blood and the excretion of sugar and acetone in the urine; and it enables the diabetic organism to consume sugar. It also lessens or prevents hyperglycæmia produced in animals in several other ways.

Gratifying success has already attended the use of this extract in the relief of diabetic patients; much further research is, however, yet needed for development of the methods of extraction and of the routine use of the active principle.

The important physiological advance thus just reached comes as a fit reward to those who have achieved it. It is, of course, the striking result of steady work pursued by many various workers through many earlier years. Such work, we may remember, lay often open to charge by the unenlightened of being merely academic and fruitless, its reward being at the time simply the intrinsic scientific interest of the facts obtained. The Toronto investigators we may be sure would say with Pasteur, "To have the fruit there must have been cultivation of the tree." Part of the merit of the recent successful investigation has been its appreciation of possibilities indicated by previous work. But that merit is after all only a preliminary to the main achievement. The actual achievement is the deserved success of a bold attack conducted with conviction and determination and carried through in the face of formidable experimental difficulties.

[1] From the presidential address delivered to the Royal Society on November 30.

The West Indian College of Tropical Agriculture.

By Prof. J. B. FARMER, F.R.S.

THE opening of the West Indian College of Tropical Agriculture by His Excellency Sir Samuel Wilson, the Governor of Trinidad and Tobago, on October 16, was an event not merely of local, but also of Imperial interest, for it constitutes a memorable landmark in the progress of agriculture throughout the British possessions in the tropics.

The idea of such a college in the West Indies owes its inception largely to Sir Francis Watts, Imperial Commissioner of Agriculture, and the project met with support both in the West Indies and at home by men alive to the pressing need for improved facilities for agricultural education and research in the tropics.

After much preliminary exploration of various possibilities it was finally decided that the College should be located in Trinidad, and few, if any, will now question the wisdom of this decision. The Government of Trinidad has presented a magnificent site of 85 acres, at St. Augustine, which appears ample for present and, so far as can be foreseen, for future developments also. The site lies about 7 miles east of Port of Spain and is situated just south of the Main East Road, close to the junction station for the eastern and southern branches of the railway. In the opinion of the present writer, the College has secured the finest site the island could offer. Not only is the land open and well drained, but it is sufficiently exposed to the trade wind, which blows through the greater part of the year, to ensure an agreeable and healthy climate.

Further important advantage accrues to the College from its close proximity to one of the principal experimental stations and farms under the control and management of the Trinidad Department of Agriculture, the director of which, Mr. W. G. Freeman, is also a member of the governing body of the College. Thus, not only will students be able to follow the raising of such staple tropical products as sugar, cocoa, rubber, coconuts, etc., on neighbouring estates under ordinary plantation methods and conditions, but they will be able to study the same crops grown experimentally, and under rigidly scientific control. They will also become acquainted with many other tropical products not usually grown in Trinidad itself, such as cotton, camphor, spices, and so on. Furthermore, at River Estate, another large experimental station, also under the Department of Agriculture, students will have the opportunity of studying methods of propagation and cultivation of cocoa and other plants under climatic conditions sufficiently different from those prevalent at St. Augustine as to afford valuable means of comparison. Apart from the intrinsic value, both economic and scientific, of the well-planned series of experiments at River Estate, the researches there are conducted on a really large scale, and scale is a matter of no small importance when starting out on agricultural investigations.

For the present the College is housed in a building of moderate size which was already in existence on the site. It has been suitably altered and equipped, and it will provide sufficient accommodation for a limited number of students pending the erection of the new permanent buildings which it is intended shall be commenced forthwith. Residences will also be provided for the staff, and it is hoped that hostels for students may be built if, and when, funds become available. Recreation grounds for students and staff, together with refectory, common-rooms and bathrooms, are already in existence on the site.

The future of the College is well assured. In addition to granting the site, the Government of Trinidad and Tobago have given 50,000*l.* towards the cost of erection and equipment of the College, and that Government, together with the Governments of Barbados, the Leeward Islands, and the Windward Islands, are contributing an annual subvention of a half of 1 per cent. of their revenues. The Imperial Government is also providing the sum of 15,000*l.* spread over a term of five years, on the understanding that the work of the existing Imperial Department of Agriculture in the West Indies shall be carried on by the College. The latter gains in prestige by this amalgamation, for the work of the department, begun by Sir Daniel Morris and continued by Sir Francis Watts, is widely and most deservedly appreciated throughout the West Indies. Substantial contributions have also been promised by Messrs. Fry and Messrs. Cadbury, the Empire Cotton Growers' Association, and the British Cotton Growing Association, while special mention should be made of a handsome private donation by Mr. J. W. Stephens, of Trinidad. It will be seen that the enterprise has already aroused practical interest, and this augurs well for the future.

The value to the Empire of a College so favourably situated to meet the present urgent demands for training in tropical agriculture should be sufficiently obvious to every one, and its influence will not be limited to the West Indian islands alone, but cannot fail to make itself felt over far wider areas. One may perhaps be permitted to hope that this wider interest will find an expression in returns of a practical nature.

The first year's prospectus of the College has recently been issued, and copies can be obtained from Mr. A. Aspinall at the London office of the College, 14 Trinity Square, E.C. It will be noted that the academic year has been made to conform with that of British universities, and it is a fortunate circumstance that the agricultural and climatic conditions in Trinidad happen to render such an arrangement a suitable one. The following courses and facilities for study have been provisionally arranged:

(1) Diploma course.

(2) One-year course in elementary agricultural science.

(3) Courses for agricultural officers, scientific and administrative.

(4) Post-graduate research.

The diploma course will extend over three years, and its object will be to give a thorough training in the science and practice of tropical agriculture to those students intending to become either tropical planters, investigators or experts in different branches of agricultural science or technology. These students will be required to have passed the College entrance examina-

tion, the standard of which is intended to be that of the matriculation examination of an English university, and evidence of having passed such a matriculation examination, or other equivalent test, may be accepted by the College in lieu of its own entrance examination.

The one-year course is intended for those who require a less extensive acquaintance with the scientific aspects of agriculture, and the standard required from such entrants will be based mainly on a satisfactory school record indicating that they are able to profit by the instruction offered.

Special facilities will be afforded to officers selected for the tropical agricultural services, whether under government or otherwise, such as should enable them to obtain (through courses planned to meet individual needs) familiarity with the applications to tropical conditions of the principles they will have already acquired in Europe or elsewhere. It is difficult to exaggerate the value and importance of such training to men of this class before they proceed to take up the duties of the posts to which they may have been appointed. Hitherto there has existed a gap, largely unbridged, between the university at home and the work that awaits the scientific officer in his district, where the conditions that embrace his problems and affect their solution are so widely different from those within the range of his previous experience. The new College enables this hiatus to be short-circuited, and it should now be possible for a man in a few months to build effectively on his previous knowledge of principles. In short, he is now in a position to obtain easily, and under exceptionally favourable conditions, just that kind of wide outlook over, and reasonably intimate familiarity with, the material and environment of his prospective problems so necessary for ultimately attacking them with good prospects of success.

Perhaps, however, a word of caution may not be out of place here. In order to secure the best type of scientific officer, whether for government or for other services, it is fundamentally important that he should have received that kind of broad and thorough scientific training which only a first-rate and well-equipped university is in a position to give. It is not contended, and it must not be expected, that the training now available for scientific officers at the West Indian Agricultural College can *replace* this university type of education. What it can and will do is to utilise the results of that education, and to make it of more immediate and practical value. The motto of the College, *Via colendi haud facilis*, emphasises the difficulty of agricultural problems, and they are not going to be best attacked unless the best means are employed in the process. The combination of the home university and the tropical college unquestionably offers the best means at present in sight.

Finally, in its provision for research students the College is pursuing an excellent course. The West Indies, with the fine botanic gardens of Trinidad and Dominica, offer unrivalled opportunities to the botanist using Trinidad as a centre, and it would be difficult to find better facilities anywhere in the tropics. The relative freedom from noxious pests, the absence of the annoyance caused by the leeches of the eastern jungles, the variety and wealth of the vegetation, together with the striking ecological character it exhibits, combine to form a most attractive prospect for any young man who desires to secure that indispensable acquaintance with tropical vegetation without which no botanist can be said to be fully qualified to hold one of the more important chairs in the universities at home.

But it is, after all, by its success in promoting the welfare of agriculture, and of the industries that arise directly out of it, that the College will be finally judged. In this last connexion it is well to learn that technological courses are contemplated to prepare men to take their part in manufacturing processes. Some of these, for example sugar, are already of considerable importance in the West Indies and elsewhere. The establishment of a sugar school will constitute the first step in this direction, and gifts of up-to-date plant and machinery have already been generously promised by several engineering firms in Great Britain.

It will be obvious from the foregoing sketch—necessarily but an imperfect one—that the institution is making a good start. Sir Francis Watts and the little band of professors, all of whom have made their mark in various directions, will carry with them the best wishes of every one interested in the success of the great enterprise on which they have embarked.

The Flow of Steels at a Low Red Heat.

RECENT developments in chemical engineering have called for the provision of metallic containers capable of withstanding considerable stress at high temperatures and for long periods. The investigation of the mechanical properties of steels and alloys at these temperatures has accordingly become a matter of very direct practical importance. The existing literature of the subject almost invariably consists of graphs, in which tensile test results are plotted against the temperature at which the test was made, care being taken to eliminate the disturbing, but very important, factor of time, by carrying out each test under as nearly the same conditions as possible, the duration of each test being at most a few hours, with an actual loading time of a few minutes. It cannot fairly be claimed that such information gives more than a general indication of the relative ability of different materials to meet the working conditions usually encountered by the exhaust valve of an aero-engine or the retorts, catalyst tubes, etc., of the engineer. Certainly it does not enable a designer to construct a container which can be depended upon to maintain its shape indefinitely, at super-atmospheric temperatures when in a state of stress.

To remedy this defect in existing knowledge, Mr. J. H. Dickenson, of the Research Laboratories of Messrs. Vickers, Ltd., Sheffield, has carried out an experimental investigation, and communicated his results at the September meeting of the Iron and Steel Institute. His general conclusion is, that all the steels upon which he has worked behaved very much like highly viscous fluids at temperatures well below the

critical range (700° C.) and cannot be said to have any definite strength at a red heat, and that the property of principal importance to the engineer who wishes to subject highly heated steel to stress is the equivalent of the viscosity of a fluid. For the solution of a problem of immediate practical importance, he has ascertained for each of a number of steels the temperature at which the rate of flow does not exceed a very small and practically negligible amount under a uniform stress of 8·5 tons per square inch. The particular problem was the manufacture of large catalyst tubes for a synthetic ammonia process. These tubes were to be maintained at a temperature of about 600° C. under an enormous internal pressure, a long life under these conditions being essential to the economic success of the process. After due consideration it was decided to make them of a nickel-chromium alloy which was known to possess high resistance to oxidation and deformation when under stress at high temperatures.

Laboratory tests were carried out on this alloy, on pure carbon steels, on a high chromium steel, and a high-speed steel. For details of the actual experiments the original paper must be consulted. It must be noted, however, that although the mechanical conditions chosen for the tests appear to have been considered with great care, there were considerable variations in the temperature of a given test-piece which amounted to as much as ± 25° C. from a mean figure. Tests of two kinds were carried out: (*a*) those at constant load and constant temperatures, and (*b*) those at constant load and uniformly rising temperature. The extension temperature diagrams of the (*b*) series show that up to 400° C. all the steels extended alike. Thereafter, however, the curves diverged, a considerable amount of flow taking place in each case, at temperatures well below that finally reached. The range of temperature investigated extended up to nearly 1000° C.

The diagrams of the (*a*) series present some remarkable results, of which perhaps the most striking was that of the test-piece of nickel-chromium alloy (Vikro), which extended continuously from the first day of loading (at 625° C.) but only broke after 36 weeks. The diagrams bring out well the enormous influence of time in determining the temperature up to which each type of steel can support a given load (in this case 8½ tons per square inch), and by implication a load which can be borne at any given temperature. As an example, a nickel-chromium alloy withstood the above stress under a rapidly applied load at 965° C., whereas the same specimen cannot be expected to endure the same stress for considerable periods without suffering sensible deformation at a temperature exceeding 600° C. Working conditions such as those outlined demand a knowledge of the latter figure.

Mr. Dickenson concludes from his tests that the extension and eventual rupture of the test-piece under unvarying load is due almost entirely to viscous flow. Whether plastic flow affects the shape of the curves, and if so, whether the data will prove sufficient to enable the plastic to be separated from the viscous flow, is a question to which he has not yet found an answer. His curves are also interesting for the light which they throw upon the differing degrees of resistance to mechanical deformation at high temperatures, which the various steels exhibit. Moreover, in selecting material for resistance to stress at these temperatures, the nature of the stressing action must be taken into account.

In the second half of his paper, consideration is given to the very important factor of resistance to "scaling" exhibited by steels at the temperatures in question. It has been known for some time that remarkable resistance to oxidation is offered by certain nickel-chromium alloys, and, in a somewhat less degree, by high chromium steels. Mr. Dickenson has carried out systematic experiments on eight typical steels, in nine temperature ranges from 550°-600° up to 1075°-1175° C. The best results were given by a nickel-chromium alloy called "Vikro." Interesting photomicrographs are furnished, showing the varying character of the scale in the various alloys. Mr. Dickenson's research will be welcomed by chemical and metallurgical engineers, for it contains valuable information for which they have long been waiting. It is much to be hoped that he will see his way to continue his experiments.

The Manufacture of Acids during the War.[1]

By Prof. T. M. LOWRY, F.R.S.

THE three technical reports before us deal with the manufacture of sulphuric, nitric, and picric acids during the war. The reports are compiled on similar lines to those of the four earlier volumes which have already been reviewed in these columns (NATURE, April 29, 1922, p. 541); and since the methods and workmanship of Mr. W. Macnab are now well known, it is not necessary to describe in detail the type of information which they contain. It may, however, be of interest to review briefly the general situation as regards supplies of acids which had to be met by the Department of Explosives Supply, and the way in which the problem was solved by the workers of that Department, as disclosed in these three reports.

[1] Ministry of Munitions and Department of Scientific and Industrial Research. Technical Records of Explosives Supply, 1915–1918. No. 5: "Manufacture of Sulphuric Acid by Contact Process." Pp. vi+128+plates. (London: H.M. Stationery Office, 1921.) 25s. net. No. 6: "Synthetic Phenol and Picric Acid." Pp. vi+97+plates. (London: H.M. Stationery Office, 1921.) 15s. net. No. 7: "Manufacture of Nitric Acid from Nitre and Sulphuric Acid." Pp. vi+86. (London: H.M. Stationery Office, 1922.) 10s. 6*d.* net.

NITRIC ACID.

Although oxidised nitrogen was the key of the supply-problem in explosives—both propellant and H.E. (just as chlorine was the basis of the supply-problem in gas-warfare in its successive phases of chlorine, phosgene, CCl_3NO_2, $S(C_2H_4Cl)_2$, or mustard gas, etc.)—the report on the manufacture of nitric acid is undoubtedly the least important of these three, since it is much to be hoped that this country will never again be dependent on overseas

sources for its whole supply of fixed nitrogen. No more eloquent testimony to our unpreparedness in this direction could be given than the fact that, while a whole volume is devoted to the manufacture of nitric acid from nitre and sulphuric acid, there is no corresponding report on the supply of fixed nitrogen from the air, for the all-sufficient reason that there never was a supply to describe. Since, however, the two factories of Gretna and of Queen's Ferry alone were making during the war 1300 tons of nitric acid per week, and since, moreover, the loss by submarines of nitre ships from Chile was the cause of incessant anxiety, lest the whole output of explosives should be arrested by even a temporary stoppage of supplies, it was of very great importance that the utilisation of the nitre should be carried out with the highest degree of efficiency.

As usual, detailed attention resulted in economies which, in an earlier stage, would have appeared to be almost impossible. Striking evidence of the elaborate care that was called for in this very large-scale production is afforded by the fact that twenty pages of the seventh report are devoted to a description of the plant and process used for washing the sacks in which the nitre was brought from Chile! This resulted, not only in the saving of a substantial percentage of the precious nitre and in the elimination of a very serious fire risk, but also gave a higher value to the bags themselves; thus, whereas an unwashed bag could be sold for 2d., there were obtained, after washing, 60 per cent. of sound bags at 4½d. each, 39 per cent. of slit bags at 3d., and 1 per cent. of ragged bags at 9·25*l*. per ton of 1400 bags.

A more obvious source of loss arose from the decomposition by heat of a certain proportion of nitric acid into water, nitrogen peroxide, and oxygen, especially towards the end of the distillation. It is this factor which gives rise to the one important complication of the plant, namely, the provision of towers in which the nitrous fumes can be reconverted into nitric acid by contact with oxygen and water. Since this oxidation is relatively slow, it is essential to provide adequate space in the towers, in order that the gases may not pass through them too quickly. Another important point in manufacture is to secure as large a proportion as possible of nitric acid of high strength, since, as the distillation proceeds, more and more water comes over with the acid. In practice the acid was collected in two batches, the receiver being changed when the density of the distillate fell to 1·465, while the fire was extinguished when the density fell to 1·340, although a little more acid distilled over from the hot charge before the retort was tapped. In a typical case, a series of six charges gave 5·05 tons nitric acid in the form of 90 per cent. acid and 3·55 tons in the form of 83·3 per cent. acid, giving a total yield of 86·6 per cent. recovered by condensation; to this must be added, however, an estimated recovery of 5·5 per cent. in the absorption towers, giving a total yield of 92 per cent. The balance of 8 per cent. is due mainly to loss of gases from the towers, especially during the brief period of violent interaction which takes place at an early stage of the distillation; there is also a small loss of nitric acid in the nitre-cake, from which the last traces of acid cannot profitably be removed. In some instances, however, a yield of more than 97 per cent. was reached, the total loss being therefore less than 3 per cent.

An interesting problem arose from the production as a by-product of vast quantities of nitre-cake. This was sometimes thrown away, *e.g.*, by dumping in the sea, since it was difficult to find a commercial outlet for it. It was therefore a profitable process, during an early period of the war, to neutralise nitre-cake with the poorer qualities of caustic soda, and to sell the product to the glass-makers as a substitute for salt-cake. At a later stage, however, manufacturers were persuaded to make more and more use of nitre cake in place of sulphuric acid, and the cake gradually acquired a market value, except at the more outlying factories. On the other hand, the direct-conversion process for the manufacture of ammonium nitrate from sodium nitrate and ammonium sulphate led to the production of vast quantities of sodium sulphate as a by-product, for which no sufficient outlet existed, with the result that two vast glistening pyramids were accumulated as a new object of interest to be seen by travellers on the G.W.R. just before reaching Swindon. As a result of these two factors, the neutralisation of nitre-cake was changed abruptly from a commercial operation, on which a useful profit might be earned, into one in which the product was of less value than the raw material. Under these conditions the infant industry was abandoned as abruptly as if the ashes of Vesuvius had fallen upon it and converted the plants into a modern Pompeii.

SULPHURIC ACID.

The manufacture of sulphuric acid involved a two-fold problem: first, the provision of sufficient supplies of chamber-acid, the manufacture of which was as well established as that of nitric acid from sodium nitrate; and, second, the manufacture of oleum, a far more difficult operation, which might indeed be compared with the fixation of nitrogen, except that the production of oleum had been carried on during many years (although on a restricted scale corresponding with the small normal demand for this material), while the fixation of nitrogen was an altogether novel enterprise in this country. Although several new chamber plants were constructed, they have not formed the subject of a report, perhaps because the production of chamber-acid was very largely left to contractors. On the other hand, new capacity for the manufacture of oleum on a large scale was provided in several Government factories, and the experience gained in constructing and working these plants is described in the fifth report of the series.

The oleum plants were of two principal types. The first plants (*e.g.* that at Oldbury) were constructed on the Mannheim system, in which the oxidation of sulphur dioxide to the trioxide is effected by the use of ferric oxide and of platinum in series. In the later plants platinum alone was used as a catalyst. The plants at Queen's Ferry, Gretna, and Avonmouth were constructed on the Grillo system, in which the platinum is supported on a base of calcined magnesium sulphate; but a plant on the Tentelew system, which is in some respects intermediate between the other two systems, since it employs platinum as the only catalyst, but in

the more familiar form of platinised asbestos, was also taken over and worked at H.M. Factory, Pembrey. The Mannheim and Tentelew plants were constructed to burn iron pyrites; in the large Grillo plants, sulphur was burnt, among other reasons, in order to reduce the size of the towers used to purify the gases. This purification has been from the beginning the most essential feature in the successful manufacture of sulphuric acid by the contact process, and is substantially the same in all the different systems. It was, however, found that, even after the most careful purification of the gases, the proportion of sulphur dioxide converted to the trioxide was lower in the Mannheim and Tentelew plants than in the Grillos, where the efficiency often reached 94 per cent. instead of something less than 90 per cent.

While, however, the report describes in detail many elaborate technical features which were essential in order to secure high yields and efficiencies, it is of interest to find that the apparently simple operation of burning the pyrites provided an opportunity for securing improved yields, that may be compared in its simplicity with the washing of nitre bags, since it was found that careful attention to the method of building up and raking the fires resulted in the reduction of the sulphur content of the spent ore from 8 to 2 per cent. This feature proved to be so important that, in addition to an accurate time-table specifying exactly when the fires were to be raked, charged, and dropped, there was actually drawn up at the Queen's Ferry factory a chart to show exactly how the prong of the rake should be dragged or pushed through the fire in order to produce the best results, and this diagram is regarded as of sufficient importance to be reproduced in the report. The report also contains a precise specification of the way in which the fire-bars must be moved in order to remove the burnt pyrites from the furnace. It was by attention to such details as these that the high efficiencies ultimately achieved in the different factories were reached.

Perhaps one reason why chamber plants did not receive more attention was that, even when T.N.T. could be manufactured without oleum, it was still found to be advantageous to supply in this form the sulphuric acid required to make up for the losses sustained during working, *e.g.*, in the form of fumes and in the various washing waters, since in this way it was possible to avoid the final stage in the concentration of the sulphuric acid, *e.g.*, from 92 to 96 per cent., which was also the most expensive and the most wasteful part of the process.

PICRIC ACID.

The manufacture of picric acid presented a third type of problem. At the beginning of the war this acid was the only approved filling for H.E. shells, for Land Service as well as for the Navy. The demand for the acid soon outstripped the available supplies of coal-tar phenol, and it therefore became necessary to make use of coal-tar benzene as the raw material. This could be converted into picric acid by passing either through monochlorobenzene and dinitrochlorobenzene or through sodium benzenesulphonate and synthetic phenol. In this country the latter process was adopted almost exclusively. In France the chlorination process was also used, although in many cases the manufacture was arrested at the penultimate stage of dinitrophenol—a milder explosive, which gave rise to many fatalities before its toxic properties were realised and controlled with the help of proper physiological tests.

The manufacture of synthetic phenol lends itself to considerable variations in plant and process, and the sixth report contains diagrams illustrating five different variations worked out by different manufacturers. The subsequent conversion of the phenol into picric acid also included a considerable range of variants, which are set out fully in the report. It may, however, be of greater interest to refer briefly to the final chapters of the history of picric acid manufacture, in which the personal influence of the late Lord Moulton was a dominating feature. Convinced from a very early date that vast quantities of explosive would be required, he had laid down as a fundamental proposition the view that these could be obtained only by using ammonium nitrate as the main basis of the shell-filling programme. In this connexion the limited supplies of T.N.T. were of particular value, since this compound could be diluted with ammonium nitrate to five times its original weight, and even then gave an explosive mixture which was of greater power than, although not quite so violent as, T.N.T. or picric acid. The insensitiveness of this mixture, which ultimately became one of its most valuable properties, made it very difficult at first to secure effective detonation, and a maximum output of picric acid was therefore demanded in order to secure complete detonation of the largest possible proportion of shells. Many efforts were made to dilute picric acid in the same way as T.N.T., and in France (where picric acid was adhered to until the end of the war, in spite of its high cost) it was diluted with a wide range of other nitro-bodies; but the dilution of ammonium picrate with ammonium nitrate was never sufficiently successful to provide a service filling.

When, therefore, the detonation of the mixture of T.N.T. and ammonium nitrate had been improved until its equality with picric acid was at last established, there was no reasonable alternative but to abandon altogether the use of this acid, which cost three times as much, and, moreover, required nearly eight tons of imports, instead of less than two tons, in order to give one ton of finished explosive. Very severe criticism was levelled against Lord Moulton's action in spending more than a million pounds in erecting a factory for the manufacture of picric acid, which was abandoned almost as soon as it was finished; but this criticism was really only a proof of the ignorance of the critics, since the policy on which it was based was one that effected a saving of several million pounds per year, in addition to effecting a reduction of imports which was at the time of vital importance. In this, as in other problems, Lord Moulton saw clearly almost from the beginning what must be done to achieve success, and the closing down of the Avonmouth factory was the final vindication of the policy which he had adopted, and then followed persistently, in spite of all the obstacles that it had to encounter, until he had accomplished his purpose.

Prof. Max Weber.

CELEBRATION OF SEVENTIETH BIRTHDAY.

THERE are few living zoologists whose researches have taken so wide a range as have those of Prof. Max Weber of Amsterdam, whose seventieth birthday has been celebrated in Holland during the present week. As naturalist-traveller by land and sea in many parts of the world, he has brought together vast collections for study by his pupils and colleagues; as anatomist and histologist, he has studied the structure and elucidated the affinities of very diverse groups of animals from flat-worms to mammals; he has written the best text-book of mammalian anatomy and conducted one of the most important oceanographical expeditions of recent times; nor has he disdained to labour as a "mere systematist" at the description and cataloguing of species of Crustacea, fishes, and reptiles.

To select for mention the most significant among contributions to knowledge so numerous and so varied is no easy task. Among the first that come to mind are Weber's demonstration that the pattern formed by the hair-follicles in the skin of various mammals can be interpreted as derived from the scaly covering of reptilian ancestors, and the evidence he has adduced for the dismemberment of the order Edentata.

As a zoogeographer, Max Weber's studies on the fauna, and especially on the freshwater fishes, of the East Indian Archipelago will have a permanent value, whether or no "Weber's line" is to replace "Wallace's line" as the accepted limit between the Oriental and the Australian regions.

An enterprise of a very different kind carried out under Max Weber's personal leadership was the exploration of the Malayan seas in the years 1899 and 1900 by the Dutch steamship *Siboga*. The stately series of reports on this expedition, which have been appearing under his editorship since 1902, form a contribution to the science of the sea scarcely surpassed in importance save by those of the *Challenger* expedition. Dealing with only a restricted area of the ocean, but paying far more attention to the fauna and flora of the shallower waters than the naturalists of the *Challenger* were able to do, it is not too much to say that the *Siboga* expedition has given a new aspect to many problems of the distribution of marine animals in tropical seas.

It remains to be added that Madame Weber (*née* van Bosse) is a botanist of distinction, who has contributed monographs on many of the groups of seaweeds collected by the *Siboga*; she has also described the minute algæ which find a curious habitat on the hairs of sloths.

W. T. C.

Prof. D'Arcy W. Thompson has sent us the following letter signed by other British naturalists and himself:

DEAR PROFESSOR MAX WEBER,

You celebrate your seventieth birthday to-day, and we, who are your colleagues and are but a few of your many friends in England, join together to congratulate you and to wish you many years to come of work and happiness. By your long life of teaching and research, by your leadership of the *Siboga* Expedition, by your great handbook of the Mammalia, and by innumerable other important publications, you have come to be the acknowledged leader of zoology in the Netherlands and to be recognised far and wide as one of the most distinguished naturalists of our time. Your solid learning has upheld the great scientific traditions of your country, your investigations have influenced and stimulated many of us, your broad interests, your singleness of purpose, the simplicity of your life, and your genius for friendship have set an example to us all.

December 5.

A. ALCOCK.

E. J. ALLEN.	SIDNEY J. HICKSON.
CHAS. W. ANDREWS.	JAS. P. HILL.
J. H. ASHWORTH.	WM. EVANS HOYLE.
W. BATESON.	J. GRAHAM KERR.
GILBERT C. BOURNE.	E. W. MACBRIDE.
W. T. CALMAN.	W. C. MCINTOSH.
GEO. H. CARPENTER.	DORIS L. MACKINNON.
WM. J. DAKIN.	P. CHALMERS MITCHELL.
ARTHUR DENDY.	C. LLOYD MORGAN.
J. C. EWART.	EDWARD B. POULTON.
F. W. GAMBLE.	R. C. PUNNETT.
J. STANLEY GARDINER.	C. TATE REGAN.
WALTER GARSTANG.	G. ELLIOT SMITH.
JAMES F. GEMMILL.	OLDFIELD THOMAS.
SIDNEY F. HARMER.	D'ARCY W. THOMPSON.
J. R. HENDERSON.	D. M. S. WATSON.
W. A. HERDMAN.	A. SMITH WOODWARD.

Obituary.

H. J. ELWES, F.R.S.

MR. HENRY JOHN ELWES passed away on November 26, after a life full of activities spread over seventy-six years. Born heir to landed property and great wealth, his life at first promised to be that of the typical English gentleman. He was sent to school at Eton, and served for five years in the Scots Guards; afterwards he became one of the greatest travellers of modern times, led on by his love of natural history, entomology, horticulture, trees, and big game shooting. He visited Asia Minor, Tibet, Nepal, India, China, Formosa, Siberia, Caucasia, North and South America, and most if not all the countries of Europe. As a landowner, he was interested in sheep, and studied all the various breeds. He rendered important services to entomology by his enormous collections, which are now housed at South Kensington. He was a keen gardener, and introduced many beautiful and rare plants, a considerable number of which are figured in the *Botanical Magazine*. His "Monograph of the Genus Lilium" is a standard work. He aided several of the great scientific societies in many ways, and became president of the Royal Entomological Society of London and of the Royal English Arboricultural Society.

Mr. Elwes wrote numerous papers on gardening, agriculture, entomology, ornithology, and forestry. It is perhaps in the latter subject that his public services were

greatest. Fascinated by the study of trees, he brought out the greatest work on arboriculture that has been published since Loudon's monumental book, which appeared in 1838. He did much for the establishment and maintenance of the School of Forestry at the University of Cambridge, the fine building and wonderful collection of timbers in it owing much to his munificence.

Mr. Elwes was a man of splendid physique, endowed with great powers of observation and organisation; and he was a fine naturalist. His influence was always cast in favour of scientific methods. His many friends mourn the loss of a splendid and stimulating personality.

J. H. GURNEY.

THE death of Mr. John Henry Gurney will be greatly deplored by all who knew him, for he was of a singularly lovable nature, and thought no ill of any one. By this sad event, Norfolk loses her foremost naturalist—one who by work and patronage has for many years done much to advance the study of Nature in his native county. Mr. Gurney, who was seventy-five years of age, died at his residence, Keswick Hall, near Norwich, after a short illness, on November 9.

Mr. Gurney came of a family intimately associated for some generations with public affairs in Norfolk, which has been noted also for its philanthropy, and in some of its branches for a love of natural history. This devotion to the study of Nature was developed in a remarkable degree in John Henry Gurney and in his father. The latter was, in his day, the greatest authority on the birds of prey; and the son at an early age commenced to follow in his father's footsteps by devoting his attention to the study of birds, which eventually became one of the main interests of a useful life. Since the days of that remarkable man, Sir Thomas Browne (1605–1682), Norfolk has been pre-eminent among English counties for its succession of distinguished naturalists interested in local faunal investigations. Many have shared in the advance of its ornithological knowledge, including such outstanding names as Alfred Newton, Stevenson, Southwell, and the Gurneys, father and son. The latter was indefatigable in his researches and made more than 100 literary contributions to the county avifauna, including 28 annual reports, each of which brought the knowledge of the subject up-to-date; of these, the last, dealing with 1921, appeared only a few months ago.

We are indebted to Mr. Gurney for several books, the chief of which was "The Gannet, a Bird with a History"—a valuable and exhaustive contribution which will always remain a classic on its subject. Another interesting volume was entitled "The Early Annals of Ornithology." This concerns largely the British aspect of the subject, and includes much information of interest relating to birds culled from the le Strange household accounts for the years 1519–1578. In quest of bird-lore he visited Spain, Algeria, Switzerland, and Egypt, and the results of his observations appeared in the *Ibis* and the *Zoologist*, or, in the case of the last-named country, in book form under the title "The Rambles of a Naturalist."

Mr. Gurney was one of the original members of the Norfolk and Norwich Naturalists' Society, founded in 1869, and was its president in 1881–2, 1888–9, 1898–9, and in 1919–20; he was also chairman of the Norfolk Wild Birds Protection Committee, and a member of the committee of the Norwich Museum, to which institution he was a generous donor. He was a Fellow of the Linnaean and Zoological Societies, and a member of the British Ornithologists' Union.

W. E. C.

CANON EDMUND MCCLURE, whose death occurred on November 18, at the age of eighty-five years, was editorial secretary of the Society for Promoting Christian Knowledge from 1875 to 1915, during which period he controlled the great mass of publications issued by the Society. He graduated in honours both at the old Queen's University, Belfast, and at Trinity College, Dublin. He held a curacy at Belfast for ten years, and was then collated to an honorary canonry at Bristol. Among his scientific and historical works he published a Star Atlas, adapted from the German of Klein; translations of Hommel's "Hebrew Tradition," and Kittel's "Babylonian Excavations"; he also had a share in a history of the society which he served so long, and in "British Place Names." Though he did little original work, his influence on scientific and historical literature was important.

IT is announced in the *Chemiker Zeitung* of November 21 that Prof. Leo Tschugaeff died from typhus on September 26 last. Dr. Tschugaeff, who was fifty years of age, was professor of inorganic chemistry at Petrograd. He was well known for his researches, including the dimethylglyoxime reaction for nickel. The issue of November 16 reports the death on November 4 of Prof. Alfred Möller, since 1896 director of the Forestry Academy of Eberswalde, who was known for his work on mycology.

WE much regret to announce the death on November 30, at sixty-nine years of age, of Sir Isaac Bayley Balfour, K.B.E., F.R.S., late professor of botany in the University of Edinburgh and Regius Keeper of the Royal Botanic Garden, Edinburgh; also on the same day, at seventy-five years of age, of Sir Norman Moore, Bt., sometime Physician to St. Bartholomew's Hospital and president of the Royal College of Physicians.

Current Topics and Events.

AT the anniversary dinner of the Royal Society it is customary to include among the guests some public men of distinction in other fields than those with which scientific men are concerned. Among such guests this year, at the dinner held on November 30, were Mr. Justice Darling, who proposed the toast of "The Royal Society," and Mr. L. S. Amery, First Lord of the Admiralty, who responded to the toast of "The Guests." If the assembly had consisted of leading representatives of literature or art,

music or the drama, neither of these speakers would have professed, facetiously or otherwise, want of knowledge of the functions of the institution they honoured by their presence, or of the meaning of subjects surveyed by it. Mr. Justice Darling, for example, said he had heard of the Royal Society as he had heard of the equator, and had been told that the society "concerned itself with medicine and biology, and particularly natural knowledge and natural philosophy, but the moment the knowledge became unnatural—and so far as he could see most of it was—then the society had nothing more to do with it." Of course, the society was founded for the promotion of *natural* knowledge by inquiry as against *supernatural* by revelation or authority. Mr. Justice Darling should understand the distinction, for he referred to Francis Bacon several times in the course of his remarks, though always incorrectly, as "Lord" Bacon. As Sir Charles Sherrington, who presided, said, "The field of truth which the society explores is in the realm of natural knowledge, and the manner of the exploration of this field is in research." Sir Ernest Rutherford was right when, in responding to the toast of "The Medallists," he referred to the spirit of adventure possessed by every scientific pioneer. In no other department of intellectual activity is this spirit more manifest, and in none are such fertile provinces being opened. To us it seems strange, therefore, that so little is commonly understood of the origin and purpose of such a body as the Royal Society, now in its 260th year, or of the achievements of modern science represented by it.

DURING the war, when the country was short of munitions, manufacturers at their wits' end for supplies of chemicals, and medical men had to use such drugs as were available instead of those most suitable for their patients, no one had any doubt that the making of these things was a key industry and that when the war was over the Government must see to it that the importer of fine chemicals from Germany should be replaced by the British manufacturers of such products. After much tribulation the Safeguarding of Industries Act was passed to achieve this end; but thanks to the political and legal discussions that have accompanied and followed its passage and the national failing of a short memory, many people have become doubtful whether there is such a thing as a key industry. Even chemists begin to wonder whether they know a fine chemical when they see one. In these circumstances it is all to the good that somebody should restate the case; and this the Association of British Chemical Manufacturers has done in a pamphlet entitled "Shall the State Throw Away the Keys?" The publication contains numerous examples of the dependence of our staple industries on a steady supply of fine chemicals, and shows that such national and Imperial functions as the care of public health and the proper administration of tropical colonies cannot be carried on without them. Some of the most essential of these materials are now made in this country; but, as Sir William Pope points out in a foreword to the pamphlet, much remains to be done, and further developments in this direction cannot fail "if public opinion realises that a flourishing fine chemical industry is a vital necessity to the prosperity of our Empire and insists that national support is given to the young enterprise." This pamphlet should be of considerable assistance in creating an intelligent public opinion on this subject.

ON December 22 occurs the bicentenary of the death of Pierre Varignon, who will be remembered for the publication in 1687—the year Newton's "Principia" appeared—of the "Projet d'une nouvelle mécanique," the first treatise in which the whole science of statics was deduced from the principle known as the parallelogram of forces. Varignon was the son of an architect at Caen and was born in 1654. His bent for mathematics was stimulated by Descartes' work on geometry. His book immediately attracted attention, and in 1688 he was made professor of mathematics at the Collège Mazarin and a member of the Academy of Sciences. In 1704 he followed Duhamel in the chair of mathematics at the Collège de France. He suffered a good deal from ill-health, and his larger work, "Nouvelle Mécanique," did not appear till 1725. Of this treatise De Morgan once wrote, "This work was born long after its own death, and three years after its author's. The Projet of 1687 enabled all the world to act upon it; so that when the finished work was published it had long been superseded. The great feature of this work, as of the Projet, is the prominence given to the composition of forces. Varignon and Newton were forcing this commodity into the market at the same time and independently." Varignon was one of the earliest and most powerful advocates in France of the use of the differential calculus and was a correspondent of Leibniz and the Bernoullis.

EXCAVATIONS at Alfoldean, near Slinfold, a camp on Sussex Stane Street, the route by which Roman soldiers marched from Chichester to London, are described in the *Times* of November 9. Remains of officers' private quarters and of a canteen have recently been found. Among other finds was a great collection of pottery, nearly all broken, specimens of many kinds of glass, and nine copper coins ranging in date from Vespasian to the fifth-century Tetricus. Mr. Winbolt, who is in charge of the excavations, will report the results to the Sussex Archæological Society. Another discovery, at Wisley, Surrey, is an ancient village dating between 50 B.C. and A.D. 50, which is recorded in the *Times* of November 15. It is stated that in the hut dwellings fragments of broken pottery were discovered. In 1904 a great deal of pottery was discovered and the kiln in which it was burnt, while years ago, at the foot of the village, a dug-out canoe, evidently belonging to it and associated with flint implements, was found. The canoe is now in the Weybridge Museum.

THE Elizabethan building in Croydon known as the Whitgift Hospital, dating from 1599, is once more threatened with destruction; the Town Council has given notice of a Parliamentary bill to acquire

and dispose of the Hospital and Oratory for streets improvements. The matter has yet to be passed, however, by a town's meeting and afterwards by the burgesses, before it can proceed. Several times during the past twenty-five years the building has been threatened, but every effort has so far been counteracted by the local Preservation Committee and the Croydon Natural History and Scientific Society. The Royal Institute of British Architects, which has now joined forces with the local scientific society, has adopted the view that the widening of the main road through Croydon can be achieved without any interference with the buildings. In 1912 a scheme to this effect was accepted by the Croydon Council, and approved by the Local Government Board. At a conference of interested societies called by the Institute, the local and national importance of preserving Whitgift Hospital as a valuable relic of Elizabethan architecture was emphasised, and it was decided to support the 1912 scheme as providing a practical and effective road improvement which meets traffic requirements. Steps are to be taken to place these views before the proper authorities. It is to be hoped that the principle of avoiding, wherever possible, interference with historic and beautiful buildings may be increasingly supported by public opinion.

FOR nearly sixteen years Lord Carnarvon, with the assistance of Mr. Howard Carter, has been engaged in carrying out excavations in part of the site of ancient Thebes on the west bank of the Nile at Luxor. Their work has now been rewarded by an astonishing success, the details of which are described by a correspondent in the *Times* of November 30, while in the next issue Sir E. Wallis Budge explains the importance of the discovery. A sealed chamber has been opened containing the tomb of Tutankhamen, son-in-law of Amenhetep IV., now better known as Aakhenaten. The latter king, whose reign is dated at the end of the 14th century B.C., became notorious for his attempt to revive the ancient cult of the sun's disc, a movement which met with such serious opposition from the orthodox worshippers of Amen-Ra, king of the gods at Thebes, that he was obliged to retire to the place now known as Tell-al-Amarnah, where he acted as priest of Aten, or the disc. The tomb furniture of Tutankhamen is of extraordinary interest and value, including his magnificent State throne, one of the most beautiful works of art ever discovered, and a mass of splendid articles which have been as yet only imperfectly examined. Sir Wallis Budge suggests with good reason that a monograph containing a full account of this remarkable discovery should be published; "Such a book, carefully planned and written by Lord Carnarvon and Mr. Howard Carter, would crown a very fine archæological triumph, and earn the gratitude of Egyptologists, archæologists, artists, and others throughout the world." It only remains to congratulate Lord Carnarvon and Mr. Howard Carter on the success that has attended their long course of excavation, and has produced one of the most remarkable discoveries made fn Egypt in recent times.

A VERY remarkable and most valuable collection of scientific instruments of historical interest is at present on view in the Portrait Gallery of the Bodleian Library, Oxford. This collection has been formed by Mr. Lewis Evans and contains some two thousand instruments, the oldest dating from the tenth century, and among the youngest being some designed by the great-grandfather of the present owner. Mr. Evans has offered the whole of it as a free gift to the University of Oxford, on condition that suitable space and situation, meeting with his approval, be found for showing it. In the meantime the collection is to remain for exhibition in the Bodleian till the end of the summer of 1924; but it can scarcely be doubted that this magnificent gift will be gratefully accepted. By far the greater part of the collection consists of astrolabes and sundials, many of the former being of exquisite workmanship. Among them is a Persian astrolabe made by Ahmad and Mahmud, dated A.H. 374 (A.D. 984), suitable for finding the time of the day by the sun or at night by 37 stars, for finding the latitude of a place, etc. Another Persian astrolabe, ornamented with gold and silver, is dated A.D. 1227, while an equally beautiful one was made at Toledo in A.D. 1067. Passing by a number of astrolabes of European make, including one made at Oxford about 1676, we find a great variety of pocket dials, some of them having compass needles to be sensitised with loadstones, in fine mountings; also drawing and surveying instruments, and finally a library, numbering about a thousand volumes, dealing with dialling, astrolabes, and other instruments. Further particulars about this wonderful collection will be found in the *Bodleian Quarterly Record*, No. 35.

A VISIT of members of the Circle of Scientific, Technical, and Trade Journalists and representatives of the technical press to the extensive modern repair shops of the London General Omnibus Co., Ltd., at Chiswick, took place on November 27. These large works, which cover more than 30 acres and deal with the repair of a fleet of 3000 motor-buses, travelling more than 100 million car-miles in a year, have some most interesting features. The works can handle 120 vehicles weekly. The whole process of overhaul and repair is conducted on scientific lines, each vehicle being stripped, the individual parts distributed for repair, and finally reassembled on a moving conveyor in a manner reminiscent of the methods of the Ford Motor Co. One highly interesting apparatus is the special washing-machine, capable of accommodating five components such as gear boxes at a time, a caustic washing solution being pumped in at high pressure so as to wash out thoroughly all grime and grit. Three such machines are in use. There is a well-equipped canteen where 1000 men can be served with dinner in fifteen minutes, and a model first-aid department. Following the inspection of the works, an address on the "Safety First" movement in England was delivered by Mr. H. E. Blain, assistant managing director of the London Underground Railways and L.G.O. Co. group, and hon. secretary both of the London

"Safety First' Council and the British Industrial "Safety First" movement. Mr. Blain traced the growth of this movement which has made "Safety First" such a familiar term in this country, describing the work of the Drivers' Educational Committee, which has more than 7000 drivers entering annually for its awards and medals, and the equally important work done by the Schools Propaganda Committee.

AT the meeting of the Chemical Society to be held at the Institution of Mechanical Engineers, Storey's Gate, S.W.1, on Thursday, December 14, at 8 P.M., Prof. C. H. Desch will deliver a lecture entitled "The Metallurgical Applications of Physical Chemistry."

THE council of the Royal Agricultural Society of England has decided to revive the offer annually of a gold medal for an essay giving evidence of original research on any agricultural subject or on any of the cognate agricultural sciences.

AT a general meeting of the members of the Royal Institution held on December 4, Sir Arthur Keith was elected secretary in succession to the late Col. E. H. Grove-Hills. Profs. Urbain (Paris), Ehrenfest (Leyden), Knudsen (Copenhagen), Bjerknes (Christiania), and Dr. Irving Langmuir were elected honorary members.

A NEW feature in the activities of the Institute of Metals is the admission of student members. The main qualifications required of the new class are that they shall be between 17 and 25 years of age and that they shall be studying metallurgy; they will be admitted to all the usual privileges of full members with the exception that they cannot vote at meetings. Both the entrance fee and the annual subscription are substantially less than those paid by members. The new departure should do much to stimulate and guide, by contact with older and more mature men of science, the younger research workers in our laboratories and works.

AT the annual general meeting of the Faraday Society held on November 20, the following officers and council for the year 1922–1923 were elected:—*President*: Sir Robert Robertson; *Past Presidents*: Sir R. T. Glazebrook, Sir Robert A. Hadfield, Bart., Prof. A. W. Porter; *Vice-Presidents*: Prof. C. H. Desch, Prof. F. G. Donnan, Dr. J. A. Harker, Prof. T. M. Lowry, W. Murray Morrison, Prof. J. R. Partington, and Dr. G. Senter; *Treasurer*: Robert L. Mond; *Council*: W. R. Bousfield, Cosmo Johns, Dr. R. Lessing, Prof. W. C. McC. Lewis, Prof. J. W. McBain, Dr. H. Moore, C. C. Paterson, Dr. J. N. Pring, Prof. A. O. Rankine, and Dr. E. K. Rideal.

AT a General Meeting of the University of Durham Philosophical Society held on November 28, the following officers were elected:—*President*: The Earl of Durham; *Vice-Presidents*: Sir Theodore Morison, Sir Charles Parsons, Profs. T. H. Havelock, P. J. Heawood, H. J. Hutchens, Mr. Wilfred Hall; *Secretaries*: Messrs. J. W. Bullerwell, B. Millard Griffiths; *Committee*: Profs. H. G. A. Hickling, H. V. A. Briscoe, J. Wight Duff, R. F. A. Hoernle, J. L. Morison, C. J. Hawkes, F. B. Jevons, Drs. J. A. Smythe, D. Woolacott, A. A. Hall, G. R. Goldsbrough, Messrs. G. W. Caunt, A. W. Bartlett, J. L. Burchnall, S. J. Davies, S. Hoare Collins, A. D. Peacock, and W. Clarke; *Editor*: Prof. G. W. Todd; *Librarian*: Dr. F. Bradshaw.

THE Frank Wood medal of the Society of Glass Technology has been presented to Mr. G. G. Middleton, B.Sc. Tech., and Mr. H. W. Howes, B.Sc. Tech., the successful students in 1921 and 1922, respectively, in the Department of Glass Technology at the Sheffield University. In 1919 the Society decided to recognise the services Mr. Frank Wood had rendered in connexion with its foundation and handed over to the University a hundred guineas, with the condition that the income should be utilised to provide some reward to students in the glass technology department. It was decided that the reward should take the form of a medal, and that it should be associated with the name of Mr. Frank Wood, in whose honour it had been established.

A NEW edition (No. 76) of their catalogue of second-hand scientific apparatus has been issued by Messrs. C. Baker, 244 High Holborn, W.C.1. The list is divided into the customary convenient sections, and we may direct attention in particular to two of them, dealing with microscopes and astronomical apparatus respectively. Both contain a large and varied assortment of items ranging from large modern instruments to the smallest accessories.

ANOTHER of the useful and well-arranged catalogues of Messrs. W. Heffer and Sons, Ltd., Cambridge, has reached us. Its No. is 217 and it contains the titles of upwards of 1500 works arranged under the headings Mathematics and Physics (Journals and Transactions, Books printed before 1800 and Books printed after 1800), Chemistry, Chemical Technology and Metallurgy. Many books formerly the property of the late Prof. R. B. Clifton are offered for sale.

MESSRS. WATSON AND SONS, LTD., Sunic House, 43 Parker Street, Kingsway, London, W.C.2, announce that the British Thomson-Houston Co., Ltd., and the General Electric Co., Ltd., are now associated with them. This connexion implies the development of X-ray and electro-medical apparatus constructed on established electrical engineering lines, and, with the aid of the research laboratories of these companies, the incorporation of the most recent advances in physics.

WITH further reference to the remarks which have appeared in these pages on the subject of the sense of smell in birds, Mr. W. E. M'Kechnie of Chepstow Place, London, W.2, raises the question as to whether the usually well-developed olfactory mechanism in birds may not have quite a different sensory function, such as the detection of fine differences in the strength, temperature, and humidity of the air-currents encountered during flight. This was Cyon's theory, but it rests on no sure foundation of fact. In their experiments on the homing capacities of Noddy and Sooty terns, Watson and Lashley found that these powers were not affected when the nasal cavities were occluded with wax and varnished over: the birds so treated retained their remarkable faculty of finding their way back to their nests, over an unknown course, from a considerable distance.

Our Astronomical Column.

A BRIGHT NEW STAR.—A telegram just received (December 4) from the International Central Bureau of Astronomical Telegrams at Copenhagen, reports the discovery of a new star on December 1, by Zivierel of Rumania. The star is given as of the first magnitude, and its position in R.A. 18^h 48^m, and North Declination 28° 0′. It is situated just on the border between the two constellations Lyra and Hercules, but as many charts differ as to the position of the actual boundary, some uncertainty may arise as to whether the star will be called Nova Lyræ or Nova Herculis. All new stars are situated either in or on the borders of the Milky Way, and the present one is no exception, lying just on the border. The Nova will easily be picked up on a fine night, because it lies just to the south of the conspicuous constellation of Lyra, made prominent by the brilliant star Vega. The constellation is in the north-western portion of the sky in the early part of the evening. The Nova makes very nearly an equilateral triangle with the two stars ν Lyræ and β Cygni and is brighter than both these stars; α Lyræ, or Vega, is of magnitude 0·14, so will approximate closely to the brightness of the Nova, assuming that the latter is still of the first magnitude. This Nova is the brightest which has appeared since that of Nova Cygni, which was discovered in 1920.

COMETS.—A new faint comet, 1922 *d*, was discovered by Mr. Skjellerup at the Cape on November 25, being the second that he has found this year. Mr. Wood has telegraphed the following elements from Johannesburg: they show a strong resemblance to those of Comet 1892 VI., which are given for comparison; as it was under observation for three months without deviating appreciably from a parabola, identity is impossible, but the two comets may have had a common origin.

T=	1923 Jan. 1·14 G.M.T.	1892 Dec. 28·1.
ω=	260° 31′	252° 42′
Ω=	261 8	264 29
i=	23 4	24 47
log q=	9·9759	9·9893

EPHEMERIS FOR GREENWICH MIDNIGHT.

	R.A. h.	m.	s.	S. Decl.	log r.	log Δ.
Dec. 8.	12	5	48	22° 9′	0·0141	9·9426
12.	12	28	56	25 35		
16.	12	52	32	28 39	9·9937	9·9556
20.	13	16	28	31 20		

The comet should be looked for a little east of south and very low down, just before dawn. It is near ϵ Corvi on December 8, subsequently crossing Hydra into Centaurus.

The following is a continuation of the ephemeris of Baade's Comet for Greenwich midnight: this is still a fairly easy object with moderate telescopes.

	R.A. h.	m.	s.	N. Decl.	log r.	log Δ.
Dec. 11.	21	55	35	23° 33′	0·3643	0·3460
15.	22	5	27	22 44	0·3663	0·3549
19.	22	15	13	21 57	0·3684	0·3639
23.	22	24	55	21 14	0·3707	0·3730

Perrine's Periodic Comet was found by Rakamuna on Nov. 29^d, 6^h, 50^m, G.M.T.; in R.A. 8^h 5^m, 32^s; N. Decl. 0° 28′. Its daily motion is +16 sec., south 44′. The probable date of perihelion was about Oct. 20. The magnitude of the comet is 13·0.

PUBLICATIONS OF THE ASTRONOMICAL SOCIETY OF THE PACIFIC.—The October number of the Publications of the Astronomical Society of the Pacific contains a number of interesting communications. First there is a very clear and concise account of the work of the late J. C. Kapteyn, whom the writer, Mr. F. H. Seares, describes as one of the most distinguished astronomers of his generation. Kapteyn, as he says, presented the unique figure of an astronomer without a telescope, but reading through this notice it will be seen how he formed programmes for telescopic work, and how successfully he discussed the observations made. Director S. A. Mitchell, of the Leander McCormick Observatory, gives a list of the trigonometrical parallaxes of a number of stars of spectrum types A and B (headings of the tables reversed in error), data very much wanted for the initial work in determining parallaxes of other stars of the same type by the spectroscopic method. A summary of the year's work at the Mount Wilson Observatory is given by the director and assistant director, Dr. G. E. Hale and Mr. Walter S. Adams respectively. As announced in NATURE of October 7, a 50-foot interferometer telescope is being specially built for the Observatory, and it is hoped to determine with it the diameters of about thirty stars brighter than the fourth magnitude. Dr. R. G. Aitken contributes an interesting account of the two notable astronomical meetings, namely the International Astronomical Union at Rome and the celebration of the centenary of the Royal Astronomical Society in London. In the notes, among other subjects, mention is made of the success of the Crocker Eclipse Expedition from the Lick Observatory.

ANCIENT OBSERVATIONS OF AURORA.—A.H. Swinton directs attention in the Journal of the British Astronomical Association to some passages in early English chronicles which describe brilliant coloured streamers in the night sky; in all probability these were displays of auroræ, an assumption that is strengthened by the fact that in most cases the dates of the displays are separated by multiples of the sunspot cycle. They therefore become valuable for indicating probable dates of sunspot maximum. Working backward from the well-established maximum of 1860·1 with the two assumed periods (A) 11^y·156 (B) 11^y·055, the following tabular values are obtained. The time of year is stated in one case only, namely, 743 Jan. 1; in the other cases the middle of the year is assumed.

Observed Date, A.D.	Tabular Date. A	B	Observed minus Tabular. A	B	Number of Cycles from 1860. A	B
555·5	554·9	555·6	+0·6	−0·1	117	118
567·5	566·0	566·7	+1·5	+0·8	116	117
743·0	744·5	743·5	−1·5	−0·5	100	101
776·5	778·0	776·7	−1·5	−0·2	97	98
794·5	789·1	798·8	+5·4	−4·3	96	97
979·5	978·8	975·7	+0·7	+3·8	79	80

Assumption A appears on the whole to be the better; in neither case is 794·5 well represented; the original record of this does not give the year in A.D. reckoning, but states that it was "the tenth year of the reign of Brihtrick, King of Wessex."

Prof. Hirayama's list of Chinese sunspots (quoted by Prof. Turner in Mon. Not. R.A.S., vol. 74, p. 99) indicates spots on the following dates: 499 Jan. 31 (3 spots seen), 826 Mar., 832 Apr. 25, 837 Dec. 25, 842 Jan. 3, 864 Feb., 874 Jan., 974 Mar. 6. These, except the second and fourth, suggest dates of maximum in fair accord with the auroral data.

Research Items.

SURVEYS IN SPITSBERGEN.—In the *Geographical Journal* for November Mr. R. A. Frazer gives an account of some work which he did on the edge of New Friesland in company with Mr. N. E. Odell and Dr. T. G. Longstaff in August 1921. The party travelled north-eastward for about 25 miles from the head of Klaas Billen Bay into the highland ice of the interior. Crossing the watershed between the western and eastern drainage areas, they surveyed the salient features in a small area lying between the Mount Svanberg group to the south and the peaks around Mount Chernichev to the north. Weather and travelling conditions were bad, and time was short, but the work which was accomplished fills one of the gaps in the skeleton survey of the Russian Arc of Meridian Expedition of 1898–1902.

DESICCATION IN THE LAKE CHAD REGION.—In an article in the *Geographical Journal* for November on the Lake Chad region, Mr. F. W. H. Migeod returns to the much debated question of desiccation on the southern edge of the Sahara. According to Mr. Migeod there is abundant evidence of the advance of arid conditions southward into the belt of fertility in Bornu. The dry area has been steadily increasing at a great rate for at least three-quarters of a century, and apparently at a slower rate for many centuries. Mr. Migeod cites evidence from the drying up of rivers and ponds, but on the other hand he found no personal evidence of the exhaustion of wells in the part of Bornu which he visited. The evidence from changes in forest growth he does not find conclusive, but with regard to human migration, he points to the significant fact that every successive capital of the Bornu empire during the last six centuries has been south of its predecessor. The general trend of migration is southward, and whenever a new village is founded it is always in a position south of the previous site.

PROBLEMS OF MENDELIAN RATIOS.—Mr. R. A. Fisher gives an elaborate mathematical treatment (Proc. Roy. Soc. Edin. vol. 42, Part 3) of certain problems connected with Mendelian ratios. He concludes that the ratio of frequency of the various types in a Mendelian population will be stable only when selection favours the heterozygote, such factors only tending to accumulate in the stock, while other factors will tend to be eliminated. He also develops formulæ for determining the rate of mutation which is necessary to maintain the variability of a species under different conditions. We are not competent to discuss his mathematics, but some of his biological statements are perhaps open to criticism. For example, he assumes that recessive factors tend to be harmful or harmful factors recessive, whereas in man the majority of harmful factors are dominant. He also repeats the current fiction that the mutations of Œnothera are explained by the crossing-over of balanced lethal factors.

ABSORPTION OF WATER BY ROOT AND STEM TIPS.—Prof. Priestley and his students have now published the fourth in their series of studies on the anatomy and physiology of the endodermis and related structures in plants. The present contribution (*New Phytologist*, vol. 21, No. 4) considers the water relations in the growing root and stem tip. Experiments of de Vries in forcing water into roots were confirmed and extended, showing that the endodermis prevents leakage of water from the stele into the cortex. At the same time the meristematic root tip before the endodermis is organised was shown to be impervious to water under ordinary pressures. This is apparently owing to the peculiar non-cellulose composition of the cell walls in this region, in contrast to the corresponding region of the stem tip. The impervious character of this region accounts for the failure of water-leakage from root tips, and is contrary to the views of a French worker who believes that the root tip below the root-hair zone is an absorptive region.

COAL IN SOUTH AFRICA.—Memoir No. 19 of the Geological Survey of the Union of South Africa, issued recently, forms the first volume of a study of the coal resources of the Union of South Africa compiled by Mr. W. J. Wybergh. The coalfields dealt with are those of Witbank, Springs, Heidelberg, and the coalfields of the Orange Free State; they are all described in considerable detail, numerous analyses are given, and the general character and properties of the coals are fully discussed. It may be of interest to reproduce the author's estimate of the existing coal resources of the Union, although, as he points out, considerable deductions may have to be made from these figures for losses in working.

Witbank Coalfield	7,926,206,000 tons
Springs area	485,000,000 ,,
Nigel area	65,000,000 ,,
Vischkuil-Delmas area fairly proved	218,400,000 ,,
Vischkuil-Delmas area conjectural	1,411,200,000 ,,
Heidelberg South Rand area	8,064,000,000 ,,
do. other areas	965,544,000 ,,
Orange Free State above	100,000,000,000 ,,
Total	119,135,350,000 tons

THE NEW BRAUN TUBE.—Two years ago Mr. J. B. Johnson of the Research Laboratories of the Western Electrical Co., and the American Telephone and Telegraph Co., exhibited to the American Physical Society a Braun cathode ray tube operating at low voltage, and an abstract of a more complete description of the tube in its present improved form will be found in the September issue of the *Journal of the Optical Society of America and Review of Scientific Instruments*. The cathode consists of a strip of platinum covered with an oxide, the anode of a tube of platinum 1 cm. long and 0·1 cm. diameter, only 0·1 cm. from the tip of the cathode. Between cathode and anode is a metal shield with a small hole in it through which the electrons from the cathode pass. Beyond the anode are the two pairs of deflector plates at right angles to each other, which can be connected to the two sources of electromotive force which are to be compared. The electrons finally impinge on a fluorescent screen and their deflection is of the order 0·1 cm. per volt applied to the deflector plates. When the plates are replaced by coils, the same deflection is obtained per ampere turn in the coils. In the paper referred to, the hysteresis loop for iron in an alternating field and the characteristic curve for an oscillating valve tube are given. At the exhibition of the tube before the Institution of Electrical Engineers on November 16, the anode current and grid voltage curve of a valve was shown. As the cathode ray has to produce ionisation as it moves sideways, it is not possible to obtain a sharp spot at frequencies of more than 10^5 per second, but below that figure the slight pressure of mercury vapour in the tube ensures a sharp image. With the oxide cathode an electromotive force of 300 volts is sufficient to run the tube.

The Royal Society Anniversary Meeting.

ON St. Andrew's Day, November 30, the Royal Society held its anniversary meeting and Sir Charles Sherrington delivered the customary presidential address, in the opening part of which he dealt with matters affecting the society itself and science generally. Speaking of research, Sir Charles Sherrington referred to the benefaction received last year under the will of the late Miss L. A. Foulerton, who by gift had already founded the Foulerton studentship. The utilisation of the bequest came under the consideration of a large and representative committee, which recommended the creation of one or more research professorships, within the field of science specified in the bequest.

The newly instituted research professorship, together with the Mackinnon, Sorby, Tyndall, Moseley, and Foulerton research studentships, all of which are of comparatively recent date, constitute something of a scheme, although they have arisen somewhat desultorily. The studentships with one or more professorships now form a series, extending, at one end, from opportunities for workers of promise to carry their careers towards fulfilment, to, at the other end, provision for men of proved achievement to devote themselves unreservedly to research. A noteworthy feature in the administration of all these research foundations is that the recipient is in no case restricted to a particular institution. The Royal Society has no laboratory of its own, and in consequence takes advantage of the facilities for research already in existence; thus its function is rather to supplement and reinforce work already in progress.

Prof. E. H. Starling has been appointed the first Foulerton professor.

Sir Richard Threlfall and Dr. D. H. Scott, on behalf of a number of subscribers, presented to the society a portrait of Sir Joseph Thomson by Mr. Fiddes Watt.

In presenting the society's medals, Sir Charles Sherrington referred briefly to the work of each recipient. The awards are as follows:—

COPLEY MEDAL. Sir Ernest Rutherford.—Recently, Sir Ernest Rutherford and his pupils have been especially concerned with the deflections of α particles in their passage through matter, and as a result of his experiments he has been led to the view that the positive electric charge in the atom is confined to a minute nuclear region in the atom, that that region comprises nearly the whole mass of the atom, and that it has a charge equal to the electronic charge multiplied by the atomic number of the element. In this work the α particles were located by the scintillations which they produced on a zinc sulphide screen. It was found that when the screen was beyond reach of the original α particles a number, relatively small, of scintillations still remained. In some cases these additional effects are due to hydrogen atoms ejected from the nuclei of the different elements by the bombarding α particles; this disruption takes place at the expense of energy latent in the disrupting atom.

RUMFORD MEDAL. Prof. Pieter Zeeman.—Prof. Zeeman's discovery of the splitting up of spectroscopic lines under the influence of magnetic force had important results, among others, that it enabled astronomers to trace magnetic effects at the surface of the sun. Among his subsequent contributions to science is an investigation dealing with the propagation of light in moving bodies. In all earlier experiments the dispersion of light in the medium was neglected, and the irregularities in the flow of the liquid constituting the moving body, prevented accurate measurements. To obtain greater accuracy Zeeman investigated the effects in solid substances, such as quartz or glass, giving these bodies an oscillatory velocity, and applying an instantaneous photographic method, the exposure taking place when the velocity was at its maximum.

ROYAL MEDAL. Mr. Joseph Barcroft.—For the last twenty years Mr. Barcroft has been prominent for his researches on the respiratory function of the blood and its relation to the activity of the tissues. He has with various collaborators worked out the changes in the normal consumption of oxygen accompanying functional activity in various representative organs—salivary gland, kidney, cardiac and skeletal muscle, and liver. He has also worked out and thrown new light on the meaning of the dissociation curve for oxygen exhibited by blood and by pure hæmoglobin, and on the influence of dissolved salts upon that curve.

ROYAL MEDAL. Mr. Charles Thomas Rees Wilson.—Previous work having shown the important part played by dust particles in the condensation of supersaturated vapour, Mr. Wilson showed that the ions produced by the passage of X-rays act in a similar manner, thus showing the discrete nature of the ions apart from their electrical effects. Later, he was able on the same principles to render visible, and to photograph, the actual path of an α particle through a gas. More recently, while studying the phenomena of atmospheric electricity, he has measured the surface electrification of the ground, and thence the potential gradient, at any moment, and has also recorded its variation from instant to instant. Observations during the progress of thunderstorms have enabled him to estimate the amount of electricity passing in a lightning flash.

DAVY MEDAL. Prof. Jocelyn Field Thorpe.—Ethyl cyanoacetate has been investigated by Prof. Thorpe very fully. As a result there appeared an illuminating series of papers on the formation and reactions of imino compounds, giving rise to a variety of derivatives of naphthalene, hydrindene, pyridine, etc., and on the isomerism displayed by the glutaconic acids. His paper on "Spiro Compounds" was the first of a series dealing with the effect produced by the alteration of the tetrahedral angle, consequent on ring formation, on the formation and stability of a second ring joined to the existing ring by a quaternary carbon atom common to both.

DARWIN MEDAL. Prof. Reginald Crundall Punnett.—Prof. Punnett was the first to find the correct interpretation of "coupling and repulsion" in inheritance, now termed "linkage." It was known that sometimes factors belonging to distinct allelomorphic pairs were transmitted as if partially linked, but that also in other families the same factors might show repulsion. Prof. Punnett conceived that these two phenomena must depend on parental combination. Most of the modern interpretations of sex-limited inheritance have grown out of this discovery.

BUCHANAN MEDAL. Sir David Bruce.—*Trypanosoma Brucei*, the causal organism of tsetse-fly disease, is so named after its discoverer, Sir David Bruce, who likewise first showed its causal connexion with that disease and with nagana. Bruce took a leading part in the elucidation of trypanosome infections, and in the adoption of counter measures against them, and also traced the incidence in man of Mediterranean fever to transmission through the milk of goats. During the war he carried out the collection and analysis of data regarding tetanus on

a scale never previously attained, and later was instrumental in establishing the origin of trench fever and its transmission by lice.

SYLVESTER MEDAL. Prof. Tullio Levi-Civita.—The investigations by Levi-Civita in pure geometry were the necessary foundations for the important physical discoveries of Einstein and Weyl. Levi-Civita has also shown himself one of the most fertile and original of investigators in differential geometry and theoretical mechanics.

HUGHES MEDAL. Dr. Francis William Aston.—Dr. Aston, by the use of an ingenious method of focussing positive rays, has shown that a large number of the elements are complexes consisting of two or more kinds of atoms, having identical chemical properties but differing in atomic weight by one or more units. Except in the single instance of hydrogen the atomic weight of each constituent is, to the limit of accuracy, a whole number on the basis of oxygen =16.

Live Specimens of Spirula.

By Dr. JOHS. SCHMIDT, Leader of the *Dana* Expeditions, Copenhagen.

FEW animals have been of more interest to zoologists than the little cuttle-fish Spirula. Related to the extinct Belemnites, and characterised by having an interior, chambered shell, it occupies an isolated position among recent species. Dead shells (see Fig. 2) are found on the sea-shores particularly of warmer seas, where they may drift ashore in great numbers, but the animal itself has hitherto ranked among the greatest zoological rarities, of which only very few museums possess a specimen.

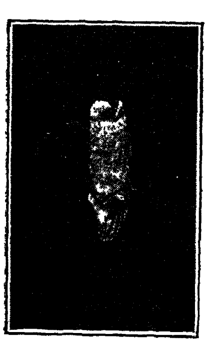

FIG. 1.—Live specimen of Spirula, moving down toward the bottom of the aquarium. While so moving, the head is directed forward (downward), the fins at the rear are thrust out vertically, and the funnel is turned upward (this last is not visible here, the figure showing the specimen in dorsal view). About half natural size. Photo by K. Stephensen.

On the third *Dana* expedition we captured considerable numbers of Spirula in the North Atlantic, and were also fortunate enough to observe many specimens alive. I propose then, in the following, to describe some of our observations, throwing light upon the habits and occurrence of the species.

Appearance.—The following remarks apply to living specimens, a point which should be emphasised, as both colour and shape are often appreciably altered by preservation. The body, or mantle, is shaped like a cylinder cut away abruptly at the back, the head and arms protruding from the front part. As seen in Fig. 1, the arms are most often kept close together, as for example when the animal is in motion, giving the anterior part of the body a conical shape. At the hinder end are two fins, roughly semicircular. Their basal parts are not parallel, but converge toward the ventral side of the animal. The fins can be pointed straight out behind (Fig. 1), or laid flat in against the hinder part (Fig. 2). In the centre of the latter, between the two fins, there is a circular disc (the terminal disc) having in the middle a small bead-like organ. At the outer edge of the disc is a ring of pigment; otherwise it is colourless. The small central bead is a light organ.

The colour differs from that of other cuttle-fish. The mantle has a peculiar whitish sheen, most resembling that of asbestos. A further similarity to the mineral lies in the fact that the surface of the mantle is often somewhat frayed or fluffy. The greater part of the mantle is without pigment; some colour there is, however, of a rusty red, in a narrow band along the anterior margin of the mantle, especially on the dorsal side. There is also pigment on the hinder end of the body and at the base of the fins. On touching a live specimen, the rusty colour at the hinder end will often almost disappear, the chromatophores contracting to little dark specks. Arms and head exhibit the silvery sheen and also pigment, the latter dense and of a rusty brown. The extremities of the arms, however, especially of the two longer ones, are somewhat lighter and lacking pigment. The funnel also is pigmented, but not at its mouth.

Movements, etc.—The movement of the Spirula is characterised throughout by the presence of the interior, chambered shell, which is situate at the posterior end of the body, and tends to lift this portion in the water. A specimen recently dead, or a live one not inclined to active movement, will therefore, if placed in an aquarium with sea water, rise to the surface, and remain suspended there head downwards, with the lighter, posterior part uppermost. If moved from this position, it will immediately swing back to it again, like a weighted tumbling figure.

On board the *Dana* we frequently observed live specimens of Spirula. When taken from the net and placed in an aquarium, they would at first invariably remain suspended at the surface of the water, motionless, and to all appearance lifeless. As a rule, however, death was only simulated. Left to themselves, they would generally come to life, and soon begin breathing and other movements. The respiratory movements are effected by rhythmical contractions of the mantle, whereby water is forced out through the funnel. As the mouth of this is turned towards the rear—*i.e.* upwards—the water flows up along the ventral side of the mantle. This vertically ascending current of water is easily noticeable, from its disturbing the frayed surface of the mantle.

Like other cuttle-fish, Spirula often makes swift,

FIG. 2.—Preserved specimen of Spirula, about 39 mm. long (the head slightly damaged). The shell seen at the side, which has 35 chambers, shows the relative size of the shell in a specimen as illustrated. The animal is seen from the ventral side: the inner shell can be discerned showing through. About natural size. Photo by K. Stephensen.

jerky movements, dashing off suddenly in any direction: upwards, downwards, or from side to side. These rushes were generally made by "backing," *i.e.* the animal moved with its hinder end forward, having first "reversed" the funnel, so as to turn its opening forward towards the head, at the same

time flattening the fins close in to the posterior end, approximately as shown in the preserved specimen, Fig. 2. Less frequently Spirula was observed in the aquarium making a forward rush with its head to the front—*i.e.* without reversing the funnel. It is possible, however, that this latter mode of progress is the usual one—for example, when in pursuit of prey.

In addition to these jerky movements, the animal also makes others at a slower rate. It may often be seen in the aquarium moving vertically downwards from the surface, head first. During the descent the fins are held vertical (see Fig. 1) and move with a rapid waving or fluttering motion which, in conjunction with the current of water from the funnel, now facing upwards (to the rear), carries the animal down towards the bottom. Sometimes it will come to a standstill in mid-water, at others it will not stop until it has reached the bottom, but so long as it remains below the surface the fins are kept in motion as described, and the funnel is pointed upwards. It may rise again slowly to the surface without altering its vertical position; the fins are then sometimes seen in motion, sometimes pressed in close to the hinder end.

In order to ascertain whether this movement of the fins was necessary to maintain the animal in the vertical position, which it adopted for the most part in our aquaria, we cut off one of the fins from a specimen, selecting a large and powerful individual for the purpose. It was at once evident that the lack of a fin in no way affected the maintenance of the vertical position; what did result was that the animal was now unable to keep under water. When placed at the bottom of the aquarium, it invariably rose again to the surface. On one occasion, when guiding it to the bottom, we happened to bring the creature into contact with the glass wall, when something new was seen. On touching the wall, it spread out its arms and clung to the glass, and was now able to keep under water. We tried to move it away from the glass by prodding it with the handle of a lancet. It relinquished its hold, but only to attach itself to the lancet handle in the same way. Evidently the eight short arms are highly sensitive to touch—the two longer less so, if at all. On this occasion also we had a sight of the animal's black, horny beak, and learned that it is capable of inflicting a powerful bite, as the handle of the lancet showed.

When left to itself the Spirula will remain suspended for hours at the surface, or lower down in the water, always in a vertical position, and with arms more or less closed in. When violently disturbed, the animal may occasionally discharge a small cloud of greyish ink. We managed to keep some specimens alive for more than two days in our small aquaria, with no aeration of the water. Generally, however, they lived only a little more than a day.

On several occasions we were able to perceive that the small bead-like organ at the posterior end is a light organ. It emits a pale, yellowish-green light, which, from the normal position of the animal in the water, is directed upward. In contrast to the light displayed by so many other marine organisms (crustacea, etc.), which flares up and fades away again, the Spirula's little lamp burns continuously. We have seen the light showing uninterruptedly for hours together.

Mode of Life.—The third *Dana* expedition has made captures of Spirula in 65 hauls from 44 stations, and in every case with implements used pelagically, without touching the bottom. The depths at which our specimens were taken varied from about 2-300 metres to about 2000. The greatest quantities were found at depths from 300 to 500 metres; none were taken in the upper 200 metres of the sea, though the nets were constantly drawn within this range.

Our investigations thus indicate that the species is bathypelagic, *i.e.* pelagic in deeper water layers, and so confirm the supposition advanced by J. Hjort (Murray and Hjort, "Depths of the Ocean," p. 595, London, 1910). A. Agassiz ("Three Cruises of the *Blake*," ii. p. 61, Boston and New York, 1888), who has examined a specimen of Spirula "dredged . . . from a depth of 950 fathoms," is of opinion that "from the condition of the chromatophores of the body, it evidently lives with its posterior extremity buried to a certain extent in the mud." This conclusion is doubtless erroneous. It would be unreasonable to suppose that the creature should thus bury its hinder part—which is lighter, owing to the shell, and also carries the light organ—in the bottom. It seems far more likely that the specimen brought up in the *Blake's* dredge was not taken from the bottom at all, but captured higher up in the water when hauling in.

Size, etc.—The 95 specimens of the third *Dana* expedition vary in length from 5 to 47 millimetres (maximal length of the mantle). On arranging the measurements graphically, they fall more or less evenly distributed along the millimetre scale, with nothing to suggest the presence of different "year-classes" in the material. Judging from this, it might seem as if the propagation of the species was not restricted to a short period of the year.

At one station (St. 1157, N. of Cape Verde Islands) we found the following :—

Depth (in metres).	Length of specimens (in millimetres).
250	9, 17, 20, 22
300	7, 17, 20, 21, 22, 27, 28
500	15, 41
1000	7, 15, 19, 22

At other stations, specimens more than 40 mm. long were found both in the deepest hauls and in those nearest the surface of all the hauls containing Spirula.

The species seems to attain maturity at a length of about 30 mm. (length of mantle). At this length the males begin to be hectocotylised, and the specimens more than 30 mm. which we opened were found to have mature sex organs (the females with large, oblong, honey-coloured ova, besides smaller eggs).

As previously mentioned, the Spirula has a chambered inner shell. As the animal grows the number of chambers increases, and a turn of the shell takes place. The figures below show how the number of chambers increases with growth of the animal.

Length of mantle (mm.).	Number of chambers in shell.
12	16
20	22
38	34 (mature male)
44	38 (mature female)

Approximately, then—but only approximately—an increase of one millimetre in length answers to the formation of one fresh chamber.

While the *Dana* was at the Virgin Islands in the West Indies (St. Thomas and St. Croix), as also at Bermuda, we often found considerable numbers of Spirula shells on the shore. Most of the shells were damaged, but so far as could be determined the intact specimens generally had between 30 and 40 chambers, *i.e.* representing, from the above, fully-grown mature specimens. From this I must conclude that at any rate the bulk of the shells found washed up on the coasts are those of fully-grown Spirula

which have died of old age. When the animal is dead, and the soft parts rotting away, the shells, being lighter than water, will thus normally rise to the surface, and drift about with the surface currents, to be eventually washed ashore. *This bathypelagic species, then, becomes after death a surface form, its remains constituting a normal ingredient in the drift of the warmer seas.*

Fig. 2 serves to show the relative size of the shell as compared with that of the animal itself. The shell here illustrated has 35 chambers, and the length (of mantle) is 39 mm. Most of the undamaged shells we found on the shore were of this size.

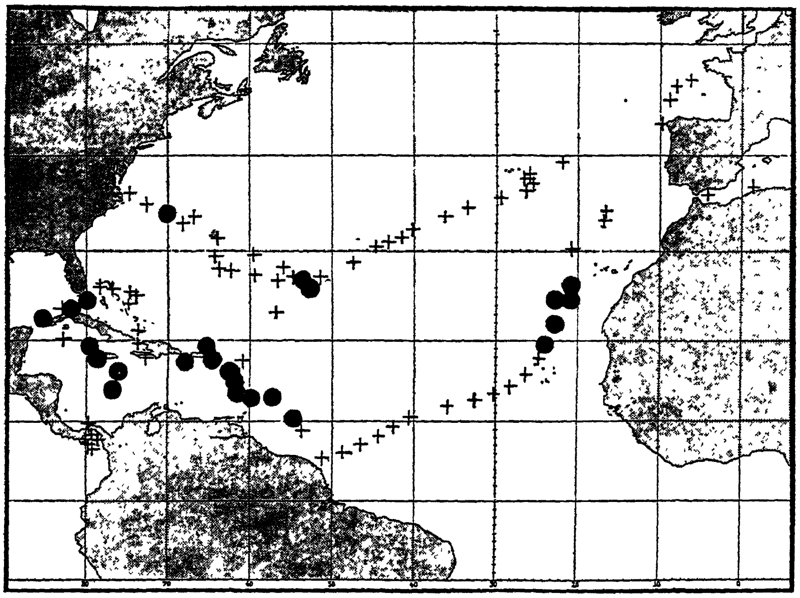

FIG. 3.—Chart showing occurrence of Spirula at stations of the *Dana* expedition. The black spots denote finds of live specimens, the crosses indicating stations where implements suited to its capture were used, but no specimens taken.

Distribution.—The first complete specimen of Spirula known to science was taken by the *Challenger* near the Banda Islands, west of New Guinea, and a few others were captured by subsequent expeditions (one by the *Blake* at Grenada, W.I., another by the *Valdivia* in the Indian Ocean, and seven by the *Michael Sars* in 1910 in the neighbourhood of the Canary Islands). The chart, Fig. 3, shows the localities where Spirula was taken by the present expedition. There were, as a matter of fact, more stations than are shown, but some lie so close together that it was impossible to indicate them on so small a chart. The stations where hauls were made which might have taken Spirula if present, but gave negative result, are marked by a cross. Our captures amounted to 95 specimens in all.

It will be seen that Spirula occurred between 10° and 35° N. Lat.: in the eastern part of the Atlantic from the Canary Islands to north of the Cape Verde Islands; in the Western Atlantic from Guiana and northward to the Virgin Islands and Puerto Rico, throughout the Caribbean; and also in the Gulf of Mexico and the Florida Straits, in the Sargasso Sea, and between Bermuda and the United States of America. From our previous investigations carried out with the *Thor*, we may conclude that the species is not found in the Mediterranean, or off the west coast of Europe from Spain to Iceland.

Solar Radiation at Helwan Observatory.

THE observations of solar radiation made at the Helwan Observatory in the years 1915 to 1921, which have recently been published,[1] lead to results of far-reaching importance.

With regard to the standardisation of instruments the position is satisfactory. The equipment of the Observatory includes two Ångström pyrheliometers made in Upsala as well as one made by the Cambridge Scientific Instrument Company, which was standardised by Prof. H. L. Callendar. There is also an Abbot silver-disc pyrheliometer. The observations indicate that if a correction of plus one per cent. is applied to determinations by the Upsala standard it comes into agreement with the Callendar and Abbot standards. A progressive deterioration in the Ångström instrument in daily use has been found, which is attributed to the deposit of dust on the blackened strips and a consequent reduction in absorbing power.

The usual practice at Helwan has been to take several observations in the course of a morning, with the sun at different heights, with the object of determining the "solar constant," the strength of the solar heat stream outside the earth's atmosphere. The usual assumption in reducing such observations is that the scattering and absorbing power of the atmosphere remains the same during the series of readings. The "solar constant" is arrived at by a process of extrapolation. In an earlier bulletin Mr. Knox-Shaw has directed attention to doubts as to the validity of this assumption, and has shown that if the air becomes less clear as the day progresses then a negative correlation between the computed "solar constant" and the computed transmission coefficient is to be expected.

It is now found that there is such correlation not only at Helwan, but also at other places for which observations have been published. The correlation coefficient averages about 0·6, and the value of the determinations of the solar constant by the extrapolation method is therefore much discredited. Further evidence of its unsuitability is furnished by the lack of correlation between the values of the solar constant found at different stations on the same day. It will be for the Smithsonian Institution to show that destructive criticism on the same lines will not affect the spectrobolometer observations on which the evidence for the day-to-day variations of the "solar constant" depends.

In the year 1919 Prof. Abbot developed a new method of observation based on the well-known fact that the more the sunlight is obstructed by dust, etc., the greater will be the glare surrounding the sun. The question has been investigated by the use of a "pyranometer" (fire-above-measure), as the instrument for determining the strength of radiation from

[1] Ministry of Public Works, Egypt: Helwan Observatory, Bull. No. 23. Observations of Solar Radiation, 1915–1921, by H. Knox-Shaw. Price 2 P.T.

the sky is termed. The type developed by Abbot and Aldrich is described in Smithsonian Misc. Collections, vol. 66, No. 7, 1916, but the name would be suitable for Mr. Dines's instrument (*Meteorological Magazine*, vol. 55, p. 189, 1920); by analogy the Callendar radiograph, which gives a record of the heat carried by the luminous rays from sun and sky and received on a horizontal surface, should be a pyranograph.

Prof. Abbot measures the heat from the sun, and also the heat from the sun plus the heat from the sky within 15° of the sun with one of these instruments, and by applying appropriate factors obtains the "solar constant." Mr. Knox-Shaw has examined a series of observations made at Calama in Chile and reduced by Prof. Abbot's staff by this method. He finds that they show no correlation between the computed values of the solar constant and the transmission coefficient. It is to be hoped that the validity of this new method will be confirmed, as it will make the regular determination of the strength of solar radiation practicable at many stations where the more elaborate routine could not be adopted. At Helwan the sun is to be observed with the Ångström apparatus once a day at a specified altitude. For the application of Abbot's method the Ångström readings will have to be supplemented by those of a pyranometer.

Natural Gas Gasoline.

THE PRODUCTION OF LIGHT OILS FROM NATURAL GAS.

By H. B. MILNER.

NATURAL gas may be of two distinct types—dry gas or wet gas. The former consists essentially of methane, with practically no other members of the paraffin series, the latter being composed of methane with varying amounts of ethane, pentane, hexane, and heptane, and certain dilutants such as nitrogen, carbon dioxide, carbon monoxide, sulphuretted hydrogen, and sometimes helium. Dry gas is normally associated with coal or decomposing vegetable matter and is rarely met with in the presence of petroleum; wet gas, on the other hand, is essentially the gas present in oil pools, either in the free state or dissolved in the oil under pressure.

The production of natural gas gasoline—as it is called—constitutes a comparatively recent development of the petroleum industry, particularly in the United States. The gas employed for this purpose is that which so frequently accumulates in the top of oil-well casings, or which, under pressure varying from a few to several hundred pounds, is forced along the flow lines leading from the casing head. Composed of lower members of the paraffin series than ordinary petrol obtained by refining crude oil, natural gas gasoline is far more volatile and inflammable, and therefore its use *per se* is normally inadmissible. But mixed with some of the heavier fractions derived from crude oil, it forms a fuel ranging from 0·660 to 0·750 in gravity, in all respects suitable for internal combustion engines of the automobile type.

There are three recognised processes for extracting oil from natural gas—the compression process, the absorption process, and the combined compression and absorption system. The compression process consists in the liquefaction by pressure and refrigeration of the heavier paraffins present in the gas, and is usually employed where the initial density of the gas exceeds 0·8, *i.e.* where the gas is rich in the heavier hydrocarbons. The plant employed entails a compressor, condensing or cooling coils and collecting tanks. The average yield of oil by this process is 2·5 gallons per m. cubic feet; 73 per cent. of the output of natural gas gasoline for 1920 in the United States was produced by the compression process.[1]

The absorption process has the advantage that it is applicable to "lean" gas, *i.e.* gas yielding anything from 0·1 to 0·5 gallons per m. cubic feet, and by this process much so-called dry gas has been utilised which would otherwise have been wasted, being of too low a grade to be treated profitably by the compression process. The absorption system necessitates passing the gas through an oil of higher gravity than ordinary petrol, from which it is recoverable by fractional distillation. The combination process is a more recent development, whereby the gas is compressed under low pressure to a smaller volume, then absorbed by seal oil and subsequently recovered by distillation. This process has been employed recently by pipe-line companies in the United States to recover gasoline from low grade wet gas accumulated in gas distributing lines. The average yield of oil by the absorption process is 0·2 gallons per m. cubic feet.

The principal States in America producing natural gas gasoline are Oklahoma, West Virginia, California, and Texas, besides eight other States giving a subordinate output. The bulk of the products is sent to the northern States and California, where in the latter case the oil is mixed with petrol obtained from low grade crude oils. Much of the Canadian natural gas gasoline is being blended with petrol obtained from Mexican crude oil, and in this way, also, many oil wells which would otherwise be derelict are, by their yield of low grade wet gas, giving good results, quite apart from the better known and more valuable gas wells.

Some idea of the remarkable growth of the industry in America can be gauged from the fact that whereas only 7½ million gallons of gas gasoline were produced in 1911, nearly 400 million gallons were produced in 1920. This constitutes more than 7 per cent. of the total production of gasoline in the United States for that year.

Quite apart from any statistical evidence, it is clear that this new industry now firmly established in America will, by its steady progress, have a far-reaching consequence on the available supplies of fuel-oil for world consumption in the future. Many fields which have hitherto been poor producers may quite conceivably be rendered sound from a commercial standpoint by the utilisation of the natural gas now allowed to run to waste. In such countries as Russia, Persia, Burma, Egypt, and Trinidad, the processes are, by reason of the large quantities of natural gas available, especially applicable, though little, if anything, has so far been done in this direction. Wherever natural gas can be controlled at the casing head, the possibility of its treatment for the recovery of light oil should be taken into account. In the fields cited above, especially in Trinidad, the value of such recovery lies not so much in the actual production of petrol, but in the enhanced value attained by low grade crude oil fractions as a result of careful mixing.

[1] "Natural Gas Gasoline in 1920," by E. G. Sievers. Min. Res. Unit. States, 1920, Part II., pp. 289-300. (Unit. States Geol. Survey.)

The Teaching of Physics to Engineering Students.

THE American Physical Society recently set up a committee to consider and report on special problems and difficulties in the teaching of physics, and the first report issued by the committee, prepared by Prof. A. W. Duff of the Worcester Polytechnic, Mass., deals with the teaching of physics to students of engineering. It summarises the opinions expressed by a large number of teachers and engineers in replies to a long list of questions addressed to them by the committee. All agree that the object of a physics course is to provide the student with a sound knowledge of the fundamental principles on which engineering depends, and that he should be shown how these principles find their application in common experiences of everyday life, so that at a later stage his knowledge of principles should be in a form immediately available for the solution of new practical problems. He must acquire the habit of searching for the principles underlying a mass of phenomena and of drawing safe conclusions from those principles. Lectures should be well thought out and the matter presented in clear form.

Some teachers think the class should be required to prepare sections of the text-book for repetition or for discussion in class, although this is felt by many to be a school method not desirable in engineering colleges. The problems set for exercise should be of a practical nature and not deteriorate into numerical substitution in a formula. Laboratory work is essential, but too great a degree of precision of results should not be demanded, the object of the work being to elucidate principles rather than attain a high order of accuracy. The relative importance of the objects to be attained in teaching physics to engineers is considered to be—first, the scientific habit of thought; second, knowledge of the laws of physics; third, initiative and ingenuity; fourth, knowledge of facts and methods; and, fifth, accurate observation.

The evidence as to present teaching in America shows that physics gets the proper proportion of time only in the best engineering colleges, and that in all cases it suffers from the inability to reason logically which most boys display on leaving school. The diversity of symbols used for the same quantity by different writers, and the difference between the engineering and scientific units, are two further difficulties under which the subject labours. A great majority of the teachers and engineers consulted were in favour of establishing a journal dealing with new instruments, methods and experiments, recent research, applications of physics, and the theory of teaching.

University and Educational Intelligence.

BELFAST.—Dr. R. C. Gray, a graduate of the University of Glasgow, has been appointed lecturer in physics in the Queen's University.

CAMBRIDGE.—It is proposed to create a University lectureship in crystallography for Mr. A. Hutchinson, Pembroke College.

A revised report on draft ordinances for the admission of women to the titles of degrees has been presented by the Syndicate appointed to prepare them. The chief modifications proposed are (1) that research students shall be supernumerary to the limit of 500 imposed on the number of women students receiving instruction in the University; (2) that a woman candidate for honours, who fails to qualify for an honours degree and is "allowed the Ordinary" shall be qualified for the title of a degree; (3) that women students be allowed to enter for pass examinations in agriculture or in architecture so long as there are no Tripos examinations in these subjects. The scale of fees has been revised in view of criticisms raised at the discussion on the first report. The Syndicate makes it clear that it is not proposed to introduce a Regulation formally admitting women to instruction in the University. It is preferred to assume that the present practice of admitting women will be continued.

LEEDS.—Applications are invited for the professorship of chemistry shortly to be vacant by the resignation of Prof. Smithells. The salary is to be 1200*l.* per annum, and the appointment will take effect on October 1, 1923. Applications for the post are to be sent to the Registrar, who will supply further information if desired.

LONDON.—An assistant lecturer in Physical Chemistry is required at University College, at a yearly salary of 300*l.* Physicists possessing a knowledge of chemistry, as well as chemists, are eligible for the post. Applications, accompanied by testimonials, record of degrees, published work, and teaching experience (if any), must reach the Secretary of the College by, at latest, Wednesday, December 20.

ACCORDING to a report prepared during the month of August for the League of Nations on "The condition of intellectual life in Austria," the professional classes and all who depend for their livelihood on intellectual work have, since the revolution of 1918, sunk into a position in which they form, in an economic sense, the lowest stratum of the community, their work being invariably worse paid than manual labour. Their physical and mental powers are consequently being sapped by insufficiency of food, and their numbers are being reduced by actual starvation. Among the organisations whereby they are striving to protect their common interests is a Central Council of Austrian Intellectual Workers, having its seat at the University of Vienna, and associated with this is an "office for providing books and instruments." This body is endeavouring to establish agreements with associations in other countries whereby second-hand or surplus books and periodicals may be obtained under conditions ensuring their fullest possible utilisation and providing for the determination of the value of Austrian books offered in exchange. One such agreement has been concluded with the Universities Library and Student Relief for Europe affiliated to the Universities Committee, Imperial War Relief Fund, General Buildings, Aldwych, W.C.2. Through this committee the universities of the United Kingdom have, during the past two years, contributed substantially towards relieving the necessities of professors and students of Austrian as well as other European universities. It is now urgently soliciting further help in money or in kind.

THE setting-up in 1918 of the standing committee of Vice-Chancellors and Principals was one of the most noteworthy events in the long history of the universities of the United Kingdom. Up to that date each university had been a law unto itself, formulating its own policy and drafting its own ordinances with little regard for the needs or the doings of the others, save in a few matters which could only be handled by the universities collectively, such, for example, as an appeal to the Chancellor

of the Exchequer or the institution of the Ph.D. degree. Outstanding interests such as these were dealt with by conferences, *ad hoc*, summoned by the Universities Bureau. At their quarterly meetings the executive heads have considered a vast number of matters of common interest, ranging from entrance tests to regulations for higher degrees, from student fees to salaries of members of staffs. After mutual consultation they report the proceedings of the committee to their respective councils and senates, which alone have power to give expression to its views, if they endorse them. When the salaries of teachers, meagre before the war, were felt by even the most enduring to be totally inadequate to meet the increased cost of living, the Association of University Teachers was formed for the purpose, in the main, of protecting the material interests of its members. We gather from the address recently delivered by its new president, Prof. J. W. McBain, of the University of Bristol, that the Association now contemplates a wider field of usefulness. It is proposed to appoint sub-committees to prepare reports on a variety of topics, to send these reports to the local associations for discussion, and finally, after the central council have hammered them into shape, to place them on record as the opinion of the Association for the benefit of the public both within and without the universities.

DR. SAMUEL P. CAPEN, the able director for several years past of the work of the American National Council on Education, was installed last month as Chancellor of the University of Buffalo. Dr. Capen, who attended the Universities' Congress at Oxford in July 1921, is well known as an authority on higher education in America. In the course of his inaugural address at Buffalo he dealt with some of the problems of urgent national importance with which educational administrators in America are confronted. Institutions of higher education of nearly every type except agricultural colleges are, he says, overcrowded, the pressure being most pronounced in the colleges of arts and sciences, where the onrush of students has threatened the efficiency of instruction. The increase in secondary school enrolments throughout the country indicates that the situation is bound to become more acute. More disconcerting than the increase in numbers in the colleges of arts and sciences are a falling off in the standard of intellectual vigour of their students, and a centrifugal tendency driving the more energetic of them to courses with such distinctly vocational aims as commerce, journalism, home economics, and industrial chemistry. A university, Dr. Capen says, is a place maintained at great expense to foster the philosophic point of view and stimulate constructive thinking, and its resources should not be consumed by those who are incapable of such things. It may be impracticable at present to devise tests which would prevent their admission, but it is relatively easy to identify them when they have been for a little while in college and "if the faculty can stand the strain" to eliminate them. As early as possible in the college course there should be provision of opportunities for independent study as in the case of honours students in British universities (whose work, by the way, is, Dr. Capen says, superior in quality to that which any American college student is required to perform), and none should be allowed to graduate who have not "demonstrated capacity for independent study and registered definite mastery of some field of study." Thus he would have American colleges adopt and apply generally to all candidates for degrees the British universities' system of honours schools.

Calendar of Industrial Pioneers.

December 10, 1631. Sir Hugh Myddelton died.—A successful London goldsmith and banker, Myddelton projected and carried through the scheme for bringing water to London from springs at Chadwell and Amwell in Hertfordshire. The New River Works were begun in 1609 and completed in 1613, the canal being 10 feet wide and more than 38 miles long. There are memorials to Myddelton at Islington, Holborn, and the Royal Exchange.

December 10, 1896. Alfred Bernhard Nobel died.—The founder of the five Nobel prizes, for which he bequeathed a sum of 1,400,000*l*., Nobel was born in Stockholm, October 21, 1833, worked for a time in his father's torpedo works at St. Petersburg, and after returning to Sweden took up the study of explosives. Dynamite was patented by him in 1867, in 1876 he patented blasting gelatine, and in 1888 he produced ballistite. With his brothers he established factories in various countries and took a share in the exploitation of the Baku oil-fields.

December 11, 1906. Jacques Augustin Normand died.—A descendant of a family of shipwrights who constructed ships at Honfleur in the 17th century, Normand became head of the well-known firm at Havre in 1871, and as such had a great share in the development of fast torpedo craft. In 1880 he built eight torpedo boats for the French Government, and in 1895 constructed the *Forban*, which for a time was the fastest vessel in the world. She was 144 feet long, and on trial on September 26, 1895, while developing 3975 horse power, reached a speed of 31·029 knots.

December 11, 1909. Ludwig Mond died.—Born in Cassel, March 7, 1839, Mond studied chemistry under Kolbe, Kirchhoff, and Bunsen, and first came to England in 1862. He introduced into England the ammonia-soda process of Solvay in 1873 with Brunner, founded important works at Winnington near Northwich, and about 1879 invented the Mond producer gas plant and discovered a method of manufacturing pure nickel. He was one of the greatest industrial chemists of his time and a generous benefactor of science. He founded the Davy-Faraday Laboratory at the Royal Institution.

December 12, 1849. Sir Marc Isambard Brunel died.—Originally an officer in the French Navy, Brunel fled from France during the Revolution, and after a short time spent in America came to England in 1799. Among his greatest achievements were the invention of the famous block-making machinery for Portsmouth Dockyard and the construction during the years 1825–1843 of the Thames Tunnel, considered at the time to be one of the sights of the world.

December 13, 1882. William Thomson Henley died.—From a porter in the London Docks, Henley rose to be one of the largest makers of telegraph cable. Starting in business as an instrument maker in 1838, he made apparatus for Wheatstone, exhibited an electro-magnetic machine at the Exhibition of 1851, and altogether made some 14,000 miles of submarine cable.

December 16, 1816. Charles, third Earl Stanhope died.—An ardent politician, and the brother-in-law of Pitt, Stanhope was also known for his love of the physical sciences and his inventive ingenuity. He constructed calculating machines, patented a process of stereotyping, introduced the Stanhope press, and attempted to drive a ship by steam.

E. C. S.

Societies and Academies.

LONDON.

Royal Society, November 23.—Sir Charles Sherrington, president, in the chair.—T. E. **Stanton**: On the characteristics of cylindrical journal lubrication at high values of the eccentricity. The arc of contact of the film was limited in extent in the experiments and the intensity of pressure was considerably higher than in normal practice; the arcs of contact varied from 14 to 35 degrees and the maximum intensities of pressure from 1·4 to 3·5 tons per sq. inch. In all the cases observed, the pressure distribution in the film has been in accordance with the hydrodynamical theory of Osborne Reynolds. By means of a careful determination of the pressure distribution in the film, and a measurement of the radius difference of bearing and journal, sufficient data have been obtained to calculate the viscosity of the lubricant and the attitude and eccentricity of the bearing. The values of the viscosity of the lubricant so calculated were in good agreement with those determined in a viscometer, and it was concluded that the calculated values of the eccentricity were trustworthy. In the case of a journal 2·5 cm. diameter, the least distance apart of the surfaces was found to vary from 0·0012 to 0·0024 mm.—J. H. **Jeans**: The propagation of earthquake waves. Earthquake waves are regarded as being compounded of a number of free vibrations of a non-homogeneous gravitating earth. In 1885, Lord Rayleigh discussed a certain type of surface waves which would travel over the earth's surface with a velocity of about $0 \cdot 92 \sqrt{(\mu/\rho)}$. It is now shown that there are additional, and far more numerous, surface waves which travel with velocities $\sqrt{(\mu/\rho)}$ and $\sqrt{((\lambda+2\mu)/\rho)}$. If such waves are generated by an earthquake at any point close to the earth's surface, they will refocus themselves upon this point after intervals which are integral multiples of $2\pi a\sqrt{(\rho/\mu)}$ and $2\pi a\sqrt{(\rho/(\lambda+2\mu))}$, the numerical values of these quantities being about 223 and 126 minutes respectively. In 1917, two series of earthquakes, each originating from the same centre, had their times given approximately by formulæ of the type—

$$t = t_0 + n_1 \times 125 \cdot 8 + n_2 \times 222 \cdot 0 \text{ minutes.}$$

It is possible that the return of waves sent out by one shock may produce a second shock by a kind of "trigger" action.—F. A. **Lindemann** and G. M. B. **Dobson**: A theory of meteors and the density and temperature of the outer atmosphere to which it leads. All major meteoric phenomena can be accounted for consistently if the luminosity of the meteor be attributed to the collision of volatilised meteoric vapour with the air molecules. From observed meteoric data the density of temperature of the air at great heights is derived in four independent ways which give consistent results. The density above 60 km. appears to be very much greater than corresponds to an isothermal atmosphere at 220° Abs., and the temperature appears to be in the neighbourhood of 300° Abs. The radiative properties of ozone may account for this high temperature.—F. C. **Thompson** and E. **Whitehead**: On the changes in iron and steel at temperatures below 280° C. Iron shows abnormalities of rate of increase of electrical resistance and electric potential against platinum at well-marked temperatures. Below 280° C. these temperatures are: 55°, 100°, 120°, 140°, 220°, and 245° C. Of these, those at 120° and 220° C. are the most important. Under the same conditions, carbide of iron possesses two well-marked points at 160° and 200° C. These may be distinct points, or the ends of a single transformation range. The etching of cementite has been studied. Broadly the reagents which darken cementite are strongly alkaline; no acid and only one neutral solution will do this. A solution has been discovered which will enable the two forms of cementite to be differentiated micrographically, but since β-cementite will change to the α form in a few days at room temperature, this etching is not always satisfactory. When samples of iron and high carbon steel are quenched from 280° C., the electrical resistivities differ from those obtained by slow cooling. As the material tempers these values gradually alter, till after some days they practically coincide with those obtained by slow cooling.—C. F. **Jenkin**: The fatigue failure of metals. A theory of the mechanism of fatigue failure in metals is offered. The theory is demonstrated by a simple model which possesses the assumed properties of the crystals forming the metal. The model, when tested like a metal test-piece, gives stress/strain curves, hysteresis loops, and the complete series of fatigue ranges of exactly the same character as those given by the metal test-piece. A method of mechanically treating a mild steel test-piece is described, which, according to the theory, should raise its fatigue range about 20 per cent.; another treatment is described which should lower the fatigue range of medium steel by about 25 per cent.—S. **Brodetsky**: The line of action of the resultant pressure in discontinuous fluid motion. The general solution of the problem of discontinuous fluid motion past any barrier can be expressed in terms of the variable introduced by Levi-Civita, by means of which the part of the barrier in contact with the moving fluid is transformed into a semi-circle. The form of the barrier is defined by the coefficients in a Taylor expansion. Although the components of the resultant pressure on the barrier have been calculated in terms of these coefficients, the line of action has not been found previously. The moment of the resultant pressure about a certain point is a simple function of the first four coefficients of the above expansion.—R. A. **Houstoun**: An investigation of the colour vision of 527 students by the Rayleigh test. Lord Rayleigh discovered in 1881 that if homogeneous yellow is matched with a mixture of homogeneous red and homogeneous green, some persons require much more red, others much more green in the mixture than the normal. Such persons have been called "anomalous trichromats." Apparatus similar to Rayleigh's was employed in the present survey. In the case of the 104 women, the frequency curve is almost a perfect case of normal variation; in the case of the men, the normal curve is present, and outside it lie the colour blind and the anomalous trichromats; the anomalous trichromats are much fewer in number than would be expected from Rayleigh's original paper.

British Mycological Society, November 18.—Mr. F. T. Brooks, president, in the chair.—M. C. **Rayner**: Calluna "cuttings." Adventitious roots produced from the leafy region of the stem showed infection by the mycorrhizal fungus from the shoot tissues. The results are completely at variance with those of Christoph.—Miss G. **Gilchrist**: Bark canker disease of apple caused by *Myxosporium corticolum*. The disease is characterised by the formation of large longitudinal scars on the sides of branches which increase rapidly towards the end of summer, and the production of wound gum. The fungus seems to be a weak parasite, except under certain conditions when the trees may be killed outright. Infection may occur from a dead spur, grafting wounds or from the region of the ground.—R. J. **Tabor**: A new fungal disease of cacao and coffee. The fungus, which is a Phycomycete, shows the

amphigynous type of fertilisation similar to certain species of Phytophthora and has a conidial stage similar to that of Muratella.—Miss E. S. **Moore**: The physiology of the dry-rot disease of potatoes in storage caused by *Fusarium cæruleum*. The existence of seasonal and varietal differences in susceptibility was confirmed. The amount and type of fungus growth is related to the carbohydrate and nitrogen supply, to the reaction of the medium and the temperature of incubation.—A. **Castellani**: Mycology in tropical medicine. The history of our knowledge of fungal diseases and the chief human parasites and their effects were considered.

Zoological Society, November 21.—Sir S. F. Harmer, vice-president, in the chair.—A. Smith **Woodward**: A skull and tusks of a mammoth from Siberia.—D. **Seth-Smith**: The shed lining of the gizzard of a hornbill.—Ivor G. S. **Montagu**: On a further collection of mammals from the Inner Hebrides.—F. R. **Wells**: The morphology and development of the chondrocranium of the larval *Clupia harengus*.—R. I. **Pocock**: The external characters of the beaver (Castoridæ) and some squirrels (Sciuridæ).—G. M. **Vevers**: On the cestode parasites from mammalian hosts which died in the Gardens of the Zoological Society of London during the years 1919–1921; with a description of a new species of Cyclorchida.—A. **Loveridge**: Notes on East African birds (chiefly nesting-habits and stomach-contents) collected 1915–1919.—E. A. **Stensiö**: Notes on certain Crossopterygians.—Ekendranath **Ghosh**: On the animal of Scaphula (Benson), with a description of a new species of Scaphula.—J. H. **Lloyd** and Edith M. **Sheppard**: A contribution to the anatomy of a hammerhead-shark (*Zygœna malleus*).—R. H. **Mehra**: Two new Indian species of the little-known genus Aulodrilus (Bretscher), aquatic Oligochæta belonging to the family Tubificidæ.—J. **Stephenson**: The Oligochæta of the Oxford University Spitsbergen expedition.—R. J. **Ortlepp**: The nematode genus Physaloptera, Rud.

Royal Meteorological Society, November 22.—Dr. C. Chree, president, in the chair.—A. H. R. **Goldie**: Circumstances determining the distribution of temperature in the upper air under conditions of high and low barometric pressure. An analysis was given of 165 observations of upper air temperature made from aeroplanes, data being classified according to whether the air was "equatorial" or "polar." The main conclusions are—(*a*) that in high-pressure systems there would usually be found, either a surface layer of polar air and above it equatorial air with the high stratosphere associated with low latitudes, or equatorial air all the way up; (*b*) that in low-pressure systems there would usually be found either (i.) all polar air and the low stratosphere of high latitudes, or perhaps (ii.) equatorial air which had been "let down" by retreating polar air, or (iii.)—near the centre of cyclones—a mixture of polar and equatorial air. These features alone would go far towards explaining (1) the absence of correlation between temperature and pressure near the surface, (2) the high positive correlation from 3 to 8 kilometres, (3) the greater height of the stratosphere over high than over low pressure, (4) the negative correlation between temperature and pressure in the stratosphere.—Rev. José **Algué**: The Manila typhoon of May 23, 1922. This typhoon traversed the central part of the Philippines in a north-westerly direction on May 20 to 23, the centre having passed practically over Manila on the morning of May 23. Manila missed the worst of the storm, and, although the barometric minimum in the present case, 742·3 mm. (29·22 inches), was lower than in the typhoons of August 31, 1920, and July 4, 1921, the damage done was much smaller; the maximum velocity of the wind, even in a few isolated gusts, was not more than 60 miles per hour. The rate of progress of the typhoon between Surigao and Maasin was 8 or 9 miles per hour; from Romblon to Boac it moved at the rate of only 5·6 miles per hour; when nearing Manila, it increased again to about 8 miles per hour; and from Manila to Iba the rate of progress was greater than 10 miles per hour. It appears that the typhoon filled up on May 26 in the China Sea east of Hainan.

PARIS.

Academy of Sciences, November 13.—M. Emile Bertin in the chair.—Paul **Vuillemin**: The morphological value of antitropic emergences. The mechanism of their production by desmonastic displacement. —Paul **Lévy**: The determination of the laws of probability by their characteristic functions.—M. **van der Corput**: Some new approximations.—W. **Sierpinski**: The existence of all classes of measurable (B) *ensembles*.—Pierre **Fatou**: Meromorphic functions of two variables.—Luc **Picart**: Statistics of faint stars in a limited region of the Milky Way.—Charles L. R. E. **Menges**: Fresnel's coefficient.—A. **Perot**: A rapid method of determining the elements of terrestrial magnetism. The principle utilised in the apparatus described is the production of induced currents in a coil rotating in the earth's field and the compensation of these currents by the production of a suitable magnetic field round the rotating coil. The accuracy claimed is about 0·1 per cent., and the actual measurement requires only ten minutes.—L. **Décombe**: The calculation of the magnetic moment of a star, starting with its axial moment of inertia, its time of rotation, and the universal constant of gravitation.—J. **Cabannes**: The polarisation and intensity of the light diffused by transparent liquids. Einstein's theory of the diffusion of light by liquids, based on the assumption that fluids are continuous media the properties of which vary slowly from one point to another, has not been confirmed by experiment. The modified theory developed by the author, assuming the existence of molecules, is shown to be in better agreement with fact. The depolarisation of diffused light by liquids furnishes a fresh proof of the discontinuity of matter.—Elis **Hjalmar**: Researches on the series of the X-rays.—P. **Fleury**: An electrical furnace with molybdenum resistance *in vacuo*. Molybdenum as a resistance material has certain advantages over tungsten; it is less fragile, more easily wound, does not contract strongly on first heating like tungsten, and is cheaper. Details are given of the construction of such a furnace, 4 cm. in diameter and 14 cm. high, giving a temperature of 1650° C. with a consumption of 2100 watts. At 1750° C. (2600 watts) the alundum tube fused.—H. **Fischer** and P. **Steiner**: The ultra-violet absorption spectra of pyridine and isoquinoline.—Georges **Chaudron** and Louis **Blanc**: The estimation of oxygen in steel. A comparison of results obtained by reduction of the steel with hydrogen either alone, or with the addition of various copper, tin, and antimony alloys. Both methods gave the same results.—L. J. **Simon**: The neutralisation of tartaric acid in presence of metallic chlorides. The neutral zone and buffer solutions.—P. **Loisel**: The radioactivity of the springs of the region of Bagnoles-de-l'Orne and its relation to the geological structure. There is a distinct relation between the radioactivity of the springs and the geological structure of the district. This conclusion is based on the measurement of the radioactivity of the water from twenty-eight springs.—J. B. **Charcot**: The geological study of the sea floor of the English Channel.—René **Souèges**: The embryo-

geny of the Caryophyllaceæ. The last stages of the development of the embryo in *Sagina procumbens*.—P. **Bugnon**: The vascular differentiation for the leaf traces in *Mercurialis annua*.—Joseph **Bouget**: The variations of coloration of flowers realised experimentally at high altitudes.—G. L. **Funke**: Supplementary summer shoots (trees and shrubs).—St. **Jonesco**: The anthocyanic pigments and phlobatanins in plants.—L. **Berger**: The existence of sympathicotropic glands in the human ovary and testicle: their relations with the interstitial gland of the testicle.—A. **Pézard** and F. **Caridroit**: Sex-linked heredity in the Gallinaceæ. Interpretation based on the existence of the neutral form and the properties of the ovarian hormone.—Alphonse **Labbé**: The distribution of the animals of the salt marshes with respect to the concentration of hydrogen ions.—Edouard **Chatton** and André **Lwoff**: The evolution of the infusoria of the Lamellibranchs. The genus Pelecyophrya, intermediate between Hypocoma and Sphenophrya.—Mme. M. **Phisalix**: The hedgehog and virus of rabies. The hedgehog has remarkable powers of defence against rabies: it attenuates or, in some cases, destroys the virus.

Official Publications Received.

Report on the Administration of the Meteorological Department of the Government of India in 1921–22. Pp. 14. (Simla: Government Central Press.) 4 annas.

Imperial Department of Agriculture for the West Indies. Sugar-Cane Experiments in the Leeward Islands: Report on Experiments with Varieties of Sugar-Cane conducted in Antigua, St. Kitts-Nevis, and Montserrat in the Season 1920–21. Pp. ii+43. (Barbados.) 1*s*.

Livingstone College. Annual Report and Statement of Accounts for the Year 1921–22. Pp. 24. (Leyton, E.10.)

The National Institute of Agricultural Botany. Third Report and Accounts, 1921–1922. Pp. 20. (Cambridge.)

Diary of Societies.

SATURDAY, DECEMBER 9.

GILBERT WHITE FELLOWSHIP (in Romano-British Gallery, British Museum), at 2.30.—W. Dale: A Demonstration.

MONDAY, DECEMBER 11.

ROYAL SOCIETY OF ARTS, at 8.—Prof. W. A. Bone: Brown Coal and Lignites (Cantor Lecture).

SURVEYORS' INSTITUTION, at 8.—Major E. Meacher: Food Production during the War.—H. German: The Agricultural Position and the Possibility of stimulating Economic Production in the Future.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Prof. J. W. Gregory: The Alps of Chinese Tibet and their Geographical Relationships.

TUESDAY, DECEMBER 12.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.

INSTITUTE OF MARINE ENGINEERS, INC., at 6.30.—Eng.-Capt. J. A. Richards: Manufacture of Solid Drawn Steel Tubes.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Technical Meeting), at 7.—A. S. Newman: Description of the "N.S." Kinematograph Camera, with Special Reference to an Electric Drive.—Dr. G. I. Higson and F. C. Toy: The Factors which determine Gamma Infinity.

JUNIOR INSTITUTION OF ENGINEERS (at Royal United Service Institution), at 7.30.—Capt. H. Riall Sankey: The Utility of Theory to the Practical Man (Presidential Address).

QUEKETT MICROSCOPICAL CLUB, at 7.30.—Dr. C. Singer: The Early Microscopists.

ILLUMINATING ENGINEERING SOCIETY (Joint Meeting with Institution of Gas Engineers, Institution of Electrical Engineers, and Institution of Municipal and County Engineers) (at Royal Society of Arts), at 8.—H. T. Harrison and others: Discussion on Recent Developments and Modern Requirements in Street-Lighting.

SOCIOLOGICAL SOCIETY (at Leplay House, 65 Belgrave Road), at 8.15.—H. W. Nevinson: Life in Bankrupt Vienna.

WEDNESDAY, DECEMBER 13.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Institution of Mechanical Engineers), at 7.45.—Lt.-Col. P. H. Johnson: Improvements in the Efficiency of Roadless Vehicles.

ROYAL SOCIETY OF ARTS, at 8.—Sir Sidney F. Harmer: The Fading of Museum Specimens.

THURSDAY, DECEMBER 14.

LINNEAN SOCIETY OF LONDON, at 5.—W. O. Howarth: The Occurrence and Distribution of *Festuca rubra* in Britain.—H. W. Pugsley: A New British *Calamintha*.—Dr. Lily Batten: The Genus *Polysiphonia*, a critical revision of the species, based upon anatomy.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—Prof. A. C. Dixon: Some Limiting Cases in the Theory of Integral Equations.—Prof. G. H. Hardy and J. E. Littlewood: Some Problems of Partitio Numerorum. V.: A Further Contribution to the Study of Goldbach's Problem.—A. E. Jolliffe: (i.) Collinear Apolar Triads on Cubic Curves; (ii.) The Inflexions and Inflexional Tangent of the Two-cusped Quartic.—T. Stuart: (i.) The Rational Parametric Solutions of—

$$x_1^4+x_2^4+x_3^4+x_4^4=2A^2w^2.$$

(ii.) The Factors of $2^{103}-1$, $2^{109}-1$.—E. C. Titchmarsh: An Expansion in a Series of Bessel Functions.—Prof. G. N. Watson: The Theorems of Clausen and Cayley on Products of Hypergeometric Functions.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—J. Caldwell: Electric Arc Welding Apparatus and Equipment.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—T. Smith: A Large Aperture Lens not corrected for Colour.—T. Smith: The Optical Cosine Law.—Dr. J. S. Anderson: Demonstration of the Measurement of the Internal Diameters of Transparent Tubes, and a Simple Differential Refractometer for Liquids.—E. R. Watts and Son, Ltd.: Exhibition and Description of a Constant Bubble (unaffected in length by changes of temperature).

SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (at Essex Hall, Essex Street), at 8.—Dr. Jane Hawthorne: Birth Control as it affects the Working Mother, to be followed by a discussion.

CHEMICAL SOCIETY (at Institution of Mechanical Engineers), at 8.—Prof. C. H. Desch: The Metallurgical Applications of Physical Chemistry.

INSTITUTE OF METALS (London Section) AND INSTITUTION OF BRITISH FOUNDRYMEN (at Institute of Marine Engineers), at 8.—Dr. P. Longmuir: Brass Foundry Practice.

CAMERA CLUB, at 8.15.—W. Sanderson: Florence and some Cities of the Etruscan League.

FRIDAY, DECEMBER 15.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—Commissioner F. de L. Booth Tucker: The Settlements of Criminal Tribes in India.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—G. Lumley: Reclamation Plant and its Operation.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—W. T. Marchmont: Notes on Printing Machinery.

SATURDAY, DECEMBER 16.

BRITISH ECOLOGICAL SOCIETY (Annual Meeting) (at University College), at 10.30 A.M.—Dr. R. Lloyd Praeger: Dispersal and Distribution (Presidential Address).—Dr. Cockayne's Work on the Tussock Grassland of New Zealand (Lantern and Specimens).—J. Ramsbottom The Mycology of the Soil.—W. H. Pearsall: Plant Distribution and Basic Ratios.

BRITISH PSYCHOLOGICAL SOCIETY (Annual General Meeting) (at University College), at 3.—S. J. F. Philpott: The Analysis of the Work Curve.—H. Gordon: Hand and Ear Tests.

PUBLIC LECTURES.

SATURDAY, DECEMBER 9.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: Ancient Egypt and the Bible.

MONDAY, DECEMBER 11.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 4.—F. W. Twort: The Nature of Ultra-microscopic Viruses. (Succeeding Lectures on December 12, 15, 18, and 19.)

CITY OF LONDON Y.M.C.A. (186 Aldersgate Street), at 6.—Sir Robert Armstrong-Jones: Fatigue and how to Combat it, for the City Worker.

TUESDAY, DECEMBER 12.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—Prof. T. J. Jehu: Fossils and What They Teach (Swiney Lectures). (Succeeding Lectures on Tuesdays, Thursdays, and Fridays—12 in all.)

INSTITUTE OF INDUSTRIAL ADMINISTRATION (at London School of Economics), at 8.—R. Twelvetrees: Standardisation of Repairs in Relation to Industrial Economy (to be followed by a Discussion).

WEDNESDAY, DECEMBER 13.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—Dr. C. W. Saleeby: Sunlight and Childhood.

THURSDAY, DECEMBER 14.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—W. G. Spencer: Vesalius and his Delineation of the Framework of the Human Body (Thomas Vicary Lecture).

ROYAL SOCIETY OF MEDICINE, at 5.15.—Sir Arthur Newsholme: Relative Values in Public Health; (2) Degrees of Preventability of Disease, etc.

UNIVERSITY COLLEGE, at 5.30.—Prof. T. Okey: Carducci.

CENTRAL LIBRARY, FULHAM, at 8.—F. T. Roche: The Influence of Finance on Industry.

SATURDAY, DECEMBER 16.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. N. Milligan: Animals without Teeth.

SATURDAY, DECEMBER 16, 1922.

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Editorial and Publishing Offices:
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Science and the Empire.

DURING the past few weeks the minds of many electors in Great Britain must have been disturbed by the storms of rhetoric, appeals to occupational interests, and promises of a Golden Age in the near future, which are common characteristics of a general election. We have seen dozens of election addresses, and almost all of them profess the desire to promote industrial development, and thus reduce the burden of unemployment. The solution of this problem is not, however, so simple as it seems on paper, and is not, moreover, solely a matter of adjusting the conflicting claims of capital and labour. The third pillar of the tripod upon which the structure of modern civilisation has been erected is creative science, yet scarcely a candidate referred to it as an essential factor of national stability as well as of progress.

This is perhaps not surprising, as the number of voters engaged in scientific research or familiar with its productive value is negligible in comparison with the electorate in general upon whose suffrages in bulk depends the position of a candidate at the poll. It is also a consequence of the fact that scientific investigators as a body do not in the public Press or on the public platform assert their claims, or pronounce their principles, so vociferously as do advocates of many social changes and reforms of relatively trivial importance. It is true that there is a National Union of Scientific Workers, but it is a Trade Union affiliated, we believe, to the Labour Party, and it exists to secure suitable conditions of work and payment for its members rather than for the extension of natural knowledge. It is therefore concerned with occupational interests alone, and has almost nothing in common with our scientific societies which month by month add more to the store of human knowledge than was gained in a century in some earlier epochs of modern history. Whatever may be thought of the strength of our position in any other respect, it cannot be questioned that as regards output of originality and inventiveness British men of science are in the front rank of the scientific army and often bear the banner in the van of progress.

We have every reason to be proud of our pioneers who to-day, as in the past, are cutting a way through virgin forests into new lands of promise from which others will gather the fruits; yet their names are mostly unknown even to our political leaders, and their works arouse no interest in the market place. Scientific men are usually indifferent whether the public gives attention to their work or no; theirs is the joy of the chase, and others may dispute over the spoils. This unworldly attitude may excite respectful admiration,

and we should be sorry to suggest that scientific investigators themselves should seek to get into the limelight or take part in the turmoil of politics. They are much better employed in the laboratory than in Parliament. What are wanted, however, are advocates of science and scientific method—men and women who know the disinterested spirit in which purely scientific inquiries are carried on and desire to introduce into social and political discussions the same impartial attitude towards evidence and fearless judgment upon it. At the present time it is in a large measure the mission of science to rebuild a shattered civilisation, not alone by providing the foundations for material progress, but also by introducing scientific methods and the scientific spirit into all fields where questions of national significance are debated.

To attain these ends there must be a much wider understanding of the service of science than exists at present. Science will not advertise itself, but there is every reason why believers in it should undertake a publicity campaign on its behalf. Dozens of interesting leaflets or short pamphlets might be written showing what science means to progressive industry and modern civilisation, and they should be distributed in thousands both to enlighten and to stimulate. Wireless telephony, for example, is a direct product of purely scientific studies. The tungsten used for the filaments in the thermionic valve and in metallic filament lamps generally, was discovered more than a century ago. It enters into the constitution of all high-speed tool steels and every magneto. Manganese, nickel, titanium, aluminium, and other essential constituents of the alloy steels now used for many engineering purposes were all first discovered in scientific laboratories. So also were the thorium and cerium used in the manufacture of incandescent gas mantles, calcium carbide for the production of acetylene gas, the methods of extracting nitrogen from the air to produce nitrates for explosives and agricultural fertilisers, and hundreds of other substances and processes which are now accepted as part of our daily life without a thought of their origin.

The most remarkable of such developments is that of helium gas discovered by Sir Norman Lockyer in the sun in 1868, found in terrestrial minerals by Sir William Ramsay twenty-six years later, and now being produced in millions of cubic feet from certain oil wells in the United States, where all airships are compelled to use this gas instead of hydrogen. It is quite possible that the practical monopoly of helium which America possesses in its rich sources of supply, may be of great significance both in the arts of peace as well as those of war. At any rate, the United States Government is quietly accumulating vast quantities of the gas compressed in cylinders for whatever needs the future may bring.

It is obvious that valuable national and Imperial service can be performed by a body which has sufficient funds to undertake active propaganda work for the extension of an understanding of the influence of scientific research and its results. The only organisation which is attempting to do this is the British Science Guild, founded in 1905 to convince the people, by means of publications and meetings, of the necessity of applying the methods of science to all branches of human endeavour and thus to further the progress and increase the welfare of the Empire. The Guild is thus not a scientific or technical society but a body of citizens united for the purpose of making the Empire strong and secure through science and the application of scientific method. Its relation to the work done in our laboratories is that of the Navy League to the Royal Navy—to watch and promote progress. Lord Askwith has just accepted the presidency of the Guild in succession to the Marquess of Crewe, who has reluctantly had to withdraw from this office on account of his appointment as British Ambassador at Paris.

Active steps are shortly to be taken by the Guild to secure adequate funds for displaying the fertility of British science not only throughout the Empire but also to the whole world. We possess a great treasure, and in these days cannot afford to let it lie hidden. It is devoutly to be hoped, therefore, that when the British Science Guild makes its appeal for funds and members there will be a rich and ready response to it, so that branches may be established throughout the Empire for the strengthening of the foundations of the knowledge upon which our position among the nations of the world depends. The British Empire Exhibition to be held in 1924 will provide an opportunity for showing what science has accomplished, and we look to a body like the British Science Guild to see that the promoters provide in the Exhibition a Temple of Science which shall be worthy of the great achievements of British genius.

Wegener's Drifting Continents.

Die Entstehung der Kontinente und Ozeane. By Dr. Alfred Wegener. Dritte gänzlich umgearbeitete Auflage. Pp. viii + 144. (Braunschweig: Friedr. Vieweg und Sohn, Akt.-Ges., 1922.) 9*s*.

HOWEVER much conservative instincts may rebel, geologists cannot refuse a hearing to Dr. Alfred Wegener, professor of meteorology in the University of Hamburg. As an oceanographer, he looks out over the boundaries of sea and land; as a meteorologist, he is interested in changes of climate in

the past. Like many scientific workers, he feels that a recognition of the Permo-Carboniferous ice-age compels him to put forward an explanation. Like them, he overlooks the fact that a century of speculation as to the causes of the glacial epoch of far more recent times has left us with a score of hypotheses amid which we wander unconvinced. The evidence of the occurrence of ice-ages becomes more and more cogent as observation spreads, and it is highly probable that they have a common cause. Prof. Wegener, in laying stress on the differences between equatorial and polar temperatures at the present day, takes up the position of greatest difficulty, and regards a regional refrigeration as necessarily connected with the poles. He does not look beyond our planet and the atmospheric conditions that now prevail. It is evident that Prof. Spitaler's laborious inquiries as to zonal fluctuations will not content him, though this author believes that he has drawn the Permo-Carboniferous glaciation into his uniformitarian net. Wegener's suggestions are far more heroic; he will shatter the outermost layer of the crust to bits, and remould it, by successive arrangements of the pieces, nearer to his heart's desire. His theme is fascinating, and his style is admirably lucid. His fondness for "hüben und drüben," a phrase, we believe, derived from Goethe, makes us wonder if he treats the globe as lightly as it was treated in the "Hexenküche." For him indeed "sie klingt wie Glas; sie ist von Ton, es giebt Scherben."

As is well known, Wegener has been much impressed by the easterly salient of S. America and the easterly indent of the African coast. If we could assure ourselves that these were at one time, and at the right time, actually in contact, most of the problems of oceanic islands, of palæoclimatology, and of the distribution of land-organisms, would be solved. Would not the instability of S. America in regard to Africa imply a similar instability between N. America and Europe, of which there is (p. 81) some geodetical evidence, accepted by Wegener, but much open to discussion? If the Atlantic is a crustal rift, the other oceans are likely to have had a similar origin. The primary crust, the silica-alumina layer, which Wegener calls *sial* in preference to Suess's less distinctive word *sal*, broke open and gave rise to continental blocks and accessory islands, which float, and even waltz, upon the *sima*, the silica-magnesia layer that underlies them.

There is a concluding figure in many Bantu dances—it survives even in folk-dances at Skansen—where two partners turn back to back, bump, and part again. The possibility of this figure on a continental scale is thrilling and attractive. If Africa once parted from America, she may woo her mate again as years pass by. The hand of the philosopher may be laid on the great land-blocks, and the occurrence of Glossopteris in India or of *Geomalacus maculosus* in Kerry may be explained by a simple process of "Verschiebung." If the fitting is not sufficiently accurate, some plasticity is granted to the sial blocks, and "Umwälzung" is also possible (pp. 35 and 41).

Wegener's conception, however, must not be taken in the spirit of a jest. Experiments on the force of gravity, made over very wide areas, have established the existence of a mass-defect under mountain-ranges and a mass-excess under lower grounds and oceans, and the sea-floor may be justly regarded as consisting of sima in large degree. It has long been recognised that a crumpled crustal mass bulges both upward and downward; it displaces what we now call sima in the depths. On the theory of isostasy, it maintains its elevation above the general surface by the fact that it displaces matter the specific gravity of which is greater than its own. Like ice in water, it floats, with a certain portion unsubmerged.

The analogy with ice is seized on by Prof. Wegener. If icebergs shift their places and "calve" by cracking on their flanks, why should not continents do the same? Let us grant that the level of the sima is reached at a less depth than that of the ocean-floors; the latter must then be composed of sima, and over them the buoyant continents may meet, and waltz, and part again. Of course they may do so; but when we are asked (p. 101) to look for the sima level about 100 fathoms down, or in some rare and dubious cases at 250 fathoms, we find that the rocks familiar to us on the land-surface are held to extend very little beyond the ordinary continental shelves. The chalk and flints dredged from 600 fathoms off western Ireland will require a new explanation. In depth, the continental blocks may go down to 100 km. Their relations to the earth as a whole, on this supposition, are shown on the same longitudinal and vertical scale in an expressive section following a great circle between S. America and Africa. The two continents are seen to be well immersed in sima. Sima (p. 113) behaves under pressure like sealing-wax, and sial like wax. Hence crumpling occurs in the sial blocks when they are pressed against the sima, though the latter in time yields and flows. Higher temperature in the depths assists this flow, and (p. 105) inclusions of sima in the base of sial blocks assist, by their greater fluidity, the yielding of the sial under folding thrusts.

We have now before us Wegener's view of the possibility of great horizontal displacements of the continents. The author points out (p. 6) that H. Wettstein in 1880 regarded the continents as subject to a

westward drift; but he viewed the oceanic areas as representing sunken land. This widely accepted notion is rejected by Wegener at the outset.

We may ask why the skin of a contracting globe became too small for the interior, and split along rifts which ultimately widened into oceans. The answer is that our globe is not contracting. It may even be expanding through rise of temperature, and Joly's conclusions are quoted as to the influence of radium in the crust. Wegener thinks that Pickering, when, in 1907, he fitted Africa and S. America together in a retrospect, was wrong in assigning an Archæan age to the great rent. The present separation (p. 7) must have occurred since Cretaceous times, if we are to account for the similarity of structural features in the two continents. That is to say, if we reject the notion that the ocean-floors represent subsided land, and if we find similar successions of strata, and ranges with similar orientations, in two separated continental blocks, these blocks must have drifted apart. We should observe the importance of that first "if"; if we agree with Wegener's hypothesis of the inadequacy of vertical movements of the crust, we are in a fair way towards salvation. "Die Theorie der Kontinentalverschiebungen vermeidet alle diese Schwierigkeiten." Even if contraction is going on below, horizontal contraction of the continental surfaces, by "Zusammenschiebung" and consequent crumpling, goes on faster (p. 11), and this causes a rending of the sial. To Wegener this does not seem to open up a new series of "Schwierigkeiten." It explains so much that it seems to require little explanation. Yet is not this a return to the conception of a Great First Cause? Accept that, and all thereafter will run smoothly.

Here again we may be charged with speaking lightly. Wegener is dealing with possible natural events. Build up an earth on certain lines, endow its parts with certain properties, some of which are suggested by well substantiated experimental work, and certain results are rendered probable.

The great length of geological time can always be appealed to as a factor. We may now ask what causes continental lands to drift and waltz. We learn (p. 132) that there is a tendency for the blocks to move towards the equator, like other bodies capable of sliding over the main curved surface of an oblate and rotating earth, and that a westward drift may also be expected. The island-loops, the garlands, are detached portions left behind; oceanic islands, however much they may be disguised by igneous upwellings, however much they may resemble volcanic cones built up from the depths, are similar fragments stranded on the sima, children that could not keep pace with their parents in the movements of the continental dance.

This is perhaps the boldest stroke of all; but the suggestion is continued on a larger and more serious scale. New Zealand is bereft of a relative that has hurried forward as Australia, Ceylon is cast off from the foot of India, Madagascar from the African flank. Prof. Wegener reads widely, and he uses biological and geological details that suggest analogies and former continuities. He quotes even (p. 40) Lange Koch's recent tracing of the Caledonian folding into Greenland (see NATURE, vol. 110, p. 91), though he fails to recognise the significance of Sigillaria in S. Africa or of Glossopteris in northern Russia (p. 68). Having rejected the probability of land-bridges and sunken regions, the floor of the Indian Ocean becomes for him a sheet of sima, left bare by separation of the continents, and we need no longer look wistfully for the lost forests of Gondwana Land, as the flying fish come on board to tell us of the secrets of the seas.

The trough-valleys that have been traced from Suez to the Shire River, though their origin is still under discussion, are regarded as signs of a rift that threatens Africa. In Fig. 36, p. 117, we have the author's view of what may occur under such a trough; since the walls are separating, room is allowed for a sinking down of fragments from them, while sima is rising under them from below. It is obvious that a melting off of the base of subsiding portions in the sima, such as the author elsewhere contemplates, would allow of a very different representation, and that Wegener's drawing is inspired by his rejection of vertical movements in the sial. Even fjords, despite their barriers of continuous rock, are for him cracks widening by lateral movement as an ice-load presses on the coast.

Wegener's strong case against general movements of subsidence and evatelion lies of course in his discovery (pp. 19-21) that the great majority of ocean-depths lies near 4700 m. below, and of land-heights near 100 m. above, the level of the sea. Attention was directed to this by the reviewer in NATURE (vol. 109, p. 202) of the second edition of Wegener's work. The conception of flotation is thus strongly supported; but it is already part of the doctrine of isostasy. Geological difficulties in Wegener's hypothesis are discussed by Philip Lake in his review of the second edition in the *Geological Magazine* for August 1922. Literature accumulates on the subject, and we have to consider such general papers as those of Harold Jeffreys "On certain geological effects of the cooling of the earth" (Proc. R. Soc., vol. 100, Sect. A, p. 122, 1921), where account is taken of the fracturing of a primitive crust, and such local studies as those of H. A. Brouwer on the garland-isles of the Dutch East Indies (Journ. Washington Acad. Sci., vol. 12, p. 172, 1922). Brouwer regards the garlands as the crests of growing anticlines,

based on crumpling masses that have a considerable lateral as well as vertical movement. Meanwhile, Wegener, flinging down his gage, certainly calls on us to justify such faiths as we at present hold. His principal geographic rearrangements are shown in a series of small maps, in one of which the northern lands are rearranged so as to explain the latest glacial epoch. The Permo-Carboniferous glaciation presents difficulties, as was pointed out in a notice of the excellent papers by Du Toit (NATURE, vol. 109, p. 757); but Wegener, when he has clustered his land-masses around the pole, shifts the pole from point to point among them, to suit their special idiosyncrasies. Nothing daunts so bold a champion. The hand of the master presses on the sial blocks or on the polar axis, and all goes well with the hypothesis.

Has the author considered, however, that no re-groupings of the furniture of the earth will account for the simultaneous reduction of ice-masses in all glaciated regions at the present day? Can, moreover, the evidence for general rises of temperature in the past be so lightly set aside? Can—but these questions are endless; those who still hope for simple explanations may well turn their eyes for light and inspiration, with Akhenaten, to the sun.

GRENVILLE A. J. COLE.

A New Treatise on Chemistry.

A Comprehensive Treatise on Inorganic and Theoretical Chemistry. By Dr. J. W. Mellor. Vol. 1. Pp. xvi + 1065. Vol. 2. Pp. viii + 894. (London: Longmans, Green and Co., 1922.) *3l. 3s.* net each vol.

THE writing of a "Comprehensive Treatise on Inorganic Chemistry" presents a problem which becomes more and more difficult with each successive year. The small text-books of a century ago soon required to be expanded into a series of volumes such as were issued by Watts in 1868, and in the English translation of Gmelin, of which 19 volumes were issued between 1848 and 1872. In recent years the growth of the subject has been so rapid that nearly all the more recent successes have been scored by teams of workers, such as those who have collaborated in the production of Thorpe's "Dictionary of Applied Chemistry" in England, and of Moissan's "Traité de chimie minérale" in France, as well as in the more recent German productions. Even so, as Dr. Mellor reminds us in his preface, the seventh edition of Gmelin, begun in 1905, is not yet completed, while three other unfinished compilations date back to 1905, 1900, and 1874 respectively. For every reason it is greatly to be hoped that Dr. Mellor will be able to carry through to completion the series of volumes of which the first two have now been issued.

In reviewing these two volumes (and perhaps paying more attention to the first than to the second), it is necessary in the first place to offer respectful homage to the author for the vast range of accurate information which he has gathered together. Almost every item of fact appears to have been abstracted from the original sources, and by a system which has left very little room for casual errors. It is, moreover, remarkable to find that an author, whose interests have generally been thought to centre themselves in the mathematical and physical aspects of chemistry, should be in a position also to deal in such an able manner with other topics, such as the early history of the science, which occupies a substantial portion of the first volume. In these chapters his references are often more numerous and earlier than those which are given in the more formal histories; thus, included in volume 1 are a number of unexpected references to the history of combustion before Jean Rey, of oxygen before Priestley, and of crystallography before Haüy, while volume 2 contains, on page 419, an amazing quotation from Roger Bacon, from which it might perhaps be supposed that metallic sodium had already been prepared in the thirteenth century! If the historical portion of the volume is dull reading, the major portion of the blame must be ascribed to the infertile character of the science during two of the three periods into which its history is divided by the author, namely, the first or mythological period, and the second or philosophical period, before it finally reached in the seventeenth century the third or scientific era. Certainly the 50 pages which are devoted to these preliminary stages fully justify the policy which has been adopted generally by teachers, even of historical chemistry, of curtailing within the narrowest limits the study of everything prior to about 1600 A.D. A lingering doubt as to whether this early period is quite so dull as it appears has, however, been raised in the mind of the reviewer by the sudden arousal of his interest when, on page 107, a series of quotations are given from a translation of Lucretius instead of a mere second-hand summary of his views on atoms.

The materials for the Treatise have already been used in part in the author's "Modern Inorganic Chemistry"; conversely, the treatise bears evidence that it has been based, in part at least, upon an expansion of the text-book. This hypothesis at any rate serves to account for some features in the arrangement of the treatise which are awkward and perhaps undesirable. Thus, in a text-book, which the student is expected to read consecutively from cover to cover, and in which the assumption is made that the reader

may begin with no previous knowledge of the subject, it is a well-known device to alternate the theoretical and the experimental sections; but this method is surely out of place in a treatise which is so extensive that it can be used only as a work of reference. In such a treatise it is merely an annoyance, and a source of unnecessary trouble to the reader, to break up the text in this way. Thus the systematic account of ozone and hydrogen peroxide is sandwiched between unrelated chapters on the kinetic theory and on electrolysis, to the obvious disadvantage both of the theoretical and the descriptive portions of the book. In the same way, and presumably for the same reason, a valuable section on chemical affinity has been buried in a chapter on hydrogen, together with a section on mass action, while sections on catalysis, on consecutive reactions, and even on neutralisation, are hidden away in a chapter on oxygen. In each of these cases the index alone gives the clue as to where the author has concealed his hidden treasures. It is perhaps even more bewildering to discover a long discussion of the indices of refraction of liquids and vapours in a chapter on crystals and crystallisation. In all these cases reference to the theoretical sections is rendered unnecessarily difficult by the way in which certain portions have been detached and redeposited in the systematic chapters of the book.

A similar confusion between the methods which are suitable for an elementary text-book and those which are required in a work of reference is also to be found in some of the figures. For example, it would have been much more satisfactory if facsimile reproductions had been given of the apparatus used by Lavoisier for the decomposition of steam by iron, and by Dumas for determining the composition of water, instead of the simplified and modernised versions of the diagrams which are given on pages 130 and 134 of volume 1; these can be of no possible value except to a student in the first stages of his chemical education, when simplicity rather than detailed accuracy is perhaps necessary. The figures are, however, not a strong feature of the treatise; thus, in volume 1 a figure has been omitted on page 89, while on page 214 a block has been printed upside down. On page 607 a block of Iceland spar with strictly rectangular faces is made to show the double refraction of a black spot on a strip of white paper without producing any refraction at all of the paper which carries the spot; the trigonal axes on page 618 also give the impression of being rectangular, and the rhombohedron of Iceland spar on page 619 does not appear to have been drawn according to any recognisable crystallographic scheme. The diagrams of spectra would also have been of greater value if they had been plotted on a scale of wave-lengths instead of on what appears to be the arbitrary scale of an instrument.

At the head of each section a quotation is given, and many of them are particularly apt and interesting; it is a pity that only the name of the author is given and that the system of references does not enable these quotations to be traced to their source. This difficulty arises also in other cases, *e.g.* on page 83, where half-a-dozen striking examples of the influence of impurities on the properties of metals are given with the name of the author but no reference to the place where the quotations may be found. The author has adopted an ingenious system of numbering separately the references to each section of perhaps half-a-dozen pages, so that no extensive re-numbering is required when additional references are inserted, and each section with its references is complete in itself; but even this excellent system has occasionally failed and most of the minor errors which have been detected in the earlier chapters have arisen in connexion with the misplaced numbering of the references. It is, however, necessary to enter a protest against the way in which, especially in the systematic portion of the book, a score or more of references are included under a single number. In the case of a student who wishes to consult the whole bibliography of a subject, no harm may be done by this system; but in the case of a chemist who wishes to look up quickly the original sources from which data have been quoted, this method of handling the references gives rise to much troublesome delay. To take only one example, on page 84, volume 2, a figure is given of an apparatus by F. P. Worley, and the text corresponding to this figure is close at hand at the foot of the page, but a careful inspection fails to reveal any number or sign with the help of which the reference to this work might be found among the two pages of closely printed references at the end of the section. The numbers which form a guide to the references are in any case not easy to find in a text-book which bristles with the subscript numbers of chemical formulæ and the superscript numbers of mathematical formulæ and equations; and it is necessary to go back to the top of page 83 and forward to page 85 in order to discover the numbers 30 and 31, with the help of which the reference to Worley's work is finally traced among the eleven references quoted under the number 30. If this system of quoting references is to be satisfactory, the reader should at least have the assurance that he will not have to go beyond the limits of a paragraph in order to find the number which will lead him to the reference.

A fault which appears for the first time in volume 2 is the introduction of abbreviations into the main portion of the text. These abbreviations may be in

place when dealing with tabular matter or in condensed abstracts; but it is very irritating to the reader to be pulled up in a purely narrative section by phrases such as "the liquid is conc. in salt-pans," or "the press. between the surfaces is normal." After such an experience the reader feels an unwonted thrill of gratitude to the Publication Committee of the Chemical Society, which does not even allow these abbreviations in the narrative portions of its abstracts. The saving of space which is achieved in this way is more than lost as the result of inserting the initials of every author even when the same author is mentioned half-a-dozen times in one paragraph. The main idea of quoting the initials of an author is probably correct, even if it appears somewhat superfluous in the case of giants such as Lavoisier and Priestley; but to repeat the initials over and over again, when the text makes it perfectly clear that the same author is being quoted, is a purism which might well be sacrificed, if only in order to find space to print in full the half-finished words which disfigure the second (but not the first) volume of the Treatise.

It will be seen that the criticisms given above refer mainly to the way in which the contents of the Treatise are presented, and not to the contents themselves. The reviewer, who spent some weeks of his vacation in mastering the contents of the two volumes before attempting to criticise them, would therefore like to conclude his comments by again expressing his amazement that a single chemist should have brought together so immense a store of information and have compiled a Treatise which every English chemist will desire to have on his shelves as a masterly guide to the literature of his science. A list of errors is being forwarded to the author.

Physiology of Respiration.

Respiration. By Dr. J. S. Haldane. (Silliman Memorial Lectures.) Pp. xviii+427. (Newhaven: Yale University Press; London: Oxford University Press, 1922.) 28*s*. net.

DR. J. S. HALDANE'S book is nominally a report of his Silliman lectures delivered at Newhaven; in reality it is an account of his life's work in physiology. No one who turns over the pages can be but impressed with the enormous advance which has been made in the physiology of respiration within the last thirty years, and the degree to which that advance has been due to Dr. Haldane's work and to the stimulating influence which he has wielded over the minds of others.

To those who teach physiology, the contents of the book are for the most part familiar ground. To such, the book at its lowest will form a convenient epitome of Dr. Haldane's works within the limits of a single cover, but many will delight in reading it because in it they will find a more perfect picture of the genius of the author than is obtainable from the perusal of his works in a less consecutive form.

One of the interesting points which will probably strike the reader is the extent to which Dr. Haldane's discoveries in the realm of pure science have been the result of problems which have confronted him in the province of industrial or applied physiology.

Of industrial physiology—now so recognised a branch of the subject in America—Dr. Haldane may almost be said to have been the founder in this country. More than thirty years ago the author was much concerned to arrive at some explanation of the fact that man could tolerate a concentration of carbon monoxide in mines which, according to what might be expected on theoretical grounds, should prove fatal. The difficulty so raised led to a complete investigation of the quantitative relations of the blood to oxygen and carbon monoxide respectively, and ultimately to his acceptance of the theory of pulmonary respiration put forward by Bohr, namely, that the pulmonary epithelium was capable of secreting oxygen (see chap. v.). It is not our object to discuss here the correctness or otherwise of these and other extremely controversial points in the book. Our concern is to point out that Dr. Haldane's refusal to leave an important point in the physiology of mines unexplained has led to a great volume of work both by himself and by others which, taken together, has given a quite unusual impulse to physiological research.

From chapters xi., xii., and xiii. it may be gleaned that in the 'nineties of last century and the early part of the present one, Haldane was much occupied with the analysis of mine air, of the air in tunnels, in ships, and in caissons. To the effects of sudden compression and decompression may probably be traced his interest in the effects of altered barometric pressure upon the human frame. The present volume facilitates the taste of the student who would acquaint himself with these problems, for hitherto much of its author's work on them has been hid away in blue books, mining reports, technical journals, and the like, so that it was difficult for the ordinary reader of physiological literature even to become appraised of its existence. In this connexion it is much to be regretted that the book lacks an index. If, as may confidently be expected, the present edition is followed at no great date by another, we hope that this omission will be made good. The book must surely be to a great extent a work of reference, and a book of reference without an index loses much of its usefulness.

The reader cannot scan the pages without observing

the large number of persons who have been privileged to collaborate with Dr. Haldane. To that company the book will mean something more than a mere recapitulation of his work or a history of the development and philosophic position, or a commentary on the action and reaction of abstract science on industrial research; it will mean something a little sacred, but something which one of them, at all events, finds some difficulty in putting into words. JOSEPH BARCROFT.

Our Bookshelf.

An Introduction to Sedimentary Petrography: With special reference to loose Detrital Deposits and their Correlation by Petrographic Methods. By Henry B. Milner. Pp. 125. (London: T. Murby and Co., 1922.) 8*s.* 6*d.* net.

THIS attractive little book deals mainly with loose detrital deposits and their correlation by petrographic methods. The first chapter gives an account of sampling, treatment, and methods of examination in about a dozen pages. The next chapter (56 pages) deals with detrital minerals and is illustrated by numerous plates showing the shapes and appearances of loose grains and crystals. Following this are two chapters in which a courageous effort is made to show the value of the evidence provided by detrital minerals as a means of stratigraphical correlation, and as an aid in palæogeographical studies. A useful bibliography, a table showing the distribution of detrital minerals in British strata, and an index are included.

It is not easy to share Mr. Milner's confidence in the inferences he draws from the evidence provided by the mineral composition of sediments. Such evidence is rather unsafe as a basis of stratigraphical correlation, owing to the rarity and local significance of instances in which detrital minerals are derived from what he calls "homogeneous distributive provinces." The difficulty of generalising safely on the genesis of detritus is illustrated very forcefully by Mr. Milner's statement that a garnet-staurolite-kyanite suite suggests derivation from a definite thermo-metamorphic province, while a sphene-apatite-zircon assemblage is indicative of acid or intermediate rock-types as sources of supply, whereas an ilmenite-anatase-rutile-brookite association points to derivation from basic or ultrabasic rock-types.

These are, to say the least, highly controversial statements, but they tend to make the subject interesting and to stimulate further work; for, as Mr. Milner very properly remarks, the aim of science should be not merely to collect facts, but to explain them, and to put them to service in the solution of larger problems. The difficulty in this particular case is that the facts available are as yet scanty and very local in their significance. Much patient fact-collecting remains to be done before it can be ascertained whether any given system or series has definite characteristics as regards the nature and mineral composition of its detritus, and what those characteristics are. Not until this work has been done will it be safe to assert that the evidence provided by detrital minerals is useful in any substantial way as a basis of stratigraphical correlation.

T. C.

Universal Problems. By H. Jamyn Brooks. Pp. 123. (Braintree, Essex: The Author, The Limes, Shalford, 1922.)

REVIEW by quotation is not usually desirable, but with books of the class to which Mr. Brooks's belongs it is the only possible method. It will suffice to quote at random three of the eight "hypotheses on which the theories discussed in the work are founded."

"1. Every element, whether it be chemical, physical or mental, is distributed in unbroken unity throughout universal space."

"5. The mode of progression of the physical forces through matter and space is by communicated combustion, as is illustrated by the ignition of a train of gunpowder."

"7. Energy is the force which becomes manifest through expansion and contraction."

At first we are inclined to be amused, but really such books are tragic, not comic. For Mr. Brooks lacks neither intelligence nor enthusiasm. He has read enormously, and he has actually printed with his own hands the little book in which his views are presented. If only that intelligence and enthusiasm had been combined with the desire and the capacity to study science seriously! If only he had given to a few elementary text-books and a short course of laboratory work the time and application he has given to encyclopædia articles and "popular" treatises! Faced with such results as this, we are forced to ask ourselves whether the "popularisation" of science is all or mainly gain. Has Prof. Eddington, for example, —his book is quoted more frequently than any other— done good to science by arousing the interest of untrained readers, or harm by encouraging the delusion that they can really understand? N. R. C.

Mechanical Testing: A Treatise in Two Volumes. By R. G. Batson and J. H. Hyde. (Directly-Useful Technical Series.) Vol. 1: *Testing of Materials of Construction.* Pp. xiii+413. (London: Chapman and Hall, Ltd., 1922.) 21*s.* net.

THE contents of this volume deal with the testing of materials of construction; the testing of apparatus, machines, and structures will be included in the second volume. The authors have had extensive experience in the National Physical Laboratory, and this is reflected in their book. A large number of engineers in this country are now alive to the importance of continually testing the materials they employ, and to such the volume will be welcome on account of the information it contains regarding modern methods of testing. The student will also find the book useful, since no college laboratory contains all the apparatus described, and text-books on materials usually have only brief sections on the apparatus employed in testing. The greater part of the volume is devoted to the testing of metals; besides the ordinary simple commercial tests, we find chapters on the repetition of stress, combined stresses, hardness testing, impact testing, and the effects of temperature. The book closes with chapters on the tests of timber, stone, brick, concrete, road materials, limes, and cements. Sufficient information is given regarding the results of methods of testing to enable the experimenter to compare his own results with average values for trustworthy materials.

The book represents a large amount of work, not merely on account of its actual contents but also on account of the number of original papers which had to be consulted. This is evidenced by the copious references at the end of each chapter. The authors are to be congratulated on the success with which they have accomplished their task.

Artificial Limbs and Amputation Stumps: A Practical Handbook. By E. Muirhead Little. Pp. vii+319. (London: H. K. Lewis and Co., Ltd., 1922.) 18*s.* net.

No surgeon who may be called upon to amputate a limb can afford to disregard the problem of fitting a prosthetic appliance to the resulting stump. Mr. Muirhead Little has recorded his conclusions, based on a wide experience in fitting artificial limbs, and his book will undoubtedly take its place as a standard work of reference on the subject in English surgical literature.

The chapter on amputation stumps is of great importance; in it the author describes the characteristics of a good stump, the conditions which prevent or delay the fitting of prostheses, and the best methods of dealing with such conditions. The actual descriptions of artificial limbs are mainly those of the British Official Prostheses, *i.e.* appliances supplied by the Ministry of Pensions. Arms are classified according to the work required to be done, and again according to the amputation region. Lower limbs are grouped corresponding to the site and type of amputation. The book is very well illustrated and is complete in its attention to details outside the actual fitting of the limb, *e.g.* the preservation and repair of the artificial leg, and the re-education of the patient. The appendix contains specifications of artificial limbs, and directions for making certalmid sockets and for fitting the light metal leg.

Industrial Nitrogen: The Principles and Methods of Nitrogen Fixation and the Industrial Applications of Nitrogen Products in the Manufacture of Explosives, Fertilizers, Dyes, etc. By P. H. S. Kempton. (Pitman's Technical Primer Series.) Pp. xii+104. (London: Sir I. Pitman and Sons, Ltd., 1922.) 2*s.* 6*d.* net.

MR. KEMPTON has provided a very brief but readable account of an important industry which has grown up within the last ten years. The descriptions of the processes are necessarily very sketchy, but enough information is given to enable one to form a reasonably accurate picture of the present state of affairs—one which, it may be mentioned, is by no means to the credit of this country. Several minor inaccuracies were noted. The yields of the various arc furnaces given on p. 15 are not the real figures. The Claude process is not the only one largely used for the manufacture of nitrogen (p. 32). Copper formate, not chloride, is used for the purification of hydrogen in the Haber process (p. 45). "Rev. A. Milner, 1871" should be "Rev. I. Milner, 1788" (p. 64). The "Ostwald-Barton system" of ammonia oxidation (p. 67) is quite adequately described by the first of the two names, and the statement that in it "a catalyst of secret composition is used instead of platinum," although it appears to have been spread abroad for the information of the credulous, is wholly without foundation.

The Beloved Ego: Foundations of the New Study of the Psyche. By Dr. W. Stekel. Authorised Translation by Rosalie Gabler. Pp. xiv+237. (London: Kegan Paul, Trench, Trubner and Co., Ltd., 1921.) 6*s.* 6*d.* net.

DIFFERENT aspects of life, such as the fight of the sexes, psychic opium, the fear of joy, the unlucky dog, to select but a few, are some of the topics of the series of essays which constitute this book. Each chapter discusses special symptoms which, in particular cases, reveal that the personality has been thrown out of perspective, and the proffered solution is that love of the self is the fundamental cause of the disturbance. Love at first sight is love of the self as reflected in another, and even the person who is always disproportionately unlucky is so, because his self-love demands that he must be unique in some one direction. The author admits his indebtedness to the work of Freud, and regards it as a step towards a new psychotherapy, but believes that sexuality has been overemphasised by Freud's followers. He aims at showing the part played by the self. The essays are in popular form and are certainly interesting and embody much sound advice.

A Textbook of Organic Chemistry. By Prof. J. S. Chamberlain. Pp. xliii+959. (London: G. Routledge and Sons, Ltd., 1922.) 16*s.* net.

PROF. CHAMBERLAIN's textbook follows the usual lines. Only important compounds are described, and attention is directed to the general relationships between groups of compounds. The style is clear and the matter well arranged, so that students beginning the serious study of organic chemistry should find the book of value, especially if supplemented by lectures, as the author intended. The printing and paper are good. From the large number of elementary textbooks on organic chemistry which have appeared recently one might be led to infer that some new methods of teaching the subject had been evolved. This does not seem to be the case.

(1) *Industrial Motor Control: Direct Current.* By A. T. Dover. (Pitman's Technical Primer Series.) Pp. xi+116. (London: Sir I. Pitman and Sons, Ltd., 1922.) 2*s.* 6*d.* net.
(2) *Switching and Switchgear.* By H. E. Poole. (Pitman's Technical Primer Series.) Pp. ix+118. (London: Sir I. Pitman and Sons, Ltd., 1922.) 2*s.* 6*d.* net.
(3) *The Testing of Transformers and Alternating Current Machines.* By Dr. C. F. Smith. (Pitman's Technical Primer Series.) Pp. xi+91. (London: Sir I. Pitman and Sons, Ltd., 1922.) 2*s.* 6*d.* net.

(1) MR. DOVER's object in his book is to discuss the principles involved in the starting and speed control of direct current motors. The principles are applied subsequently to typical control apparatus. The diagrams are well drawn and the descriptions are clear.

(2) The elementary considerations which have to be taken into account when designing apparatus for the switch-control of electric circuits are well described in Mr. Poole's book. It will form a useful introduction to more technical treatises.

(3) Dr. Smith's book will prove useful to students, and to engineers who want to revise their knowledge.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Echinoderm Larvæ and their Bearing on Classification.

IN NATURE of December 22, 1921, Prof. E. W. MacBride, in consequence of Dr. F. A. Bather's review (in NATURE of December 8, 1921) of my work, "Studies of the Development and Larval Forms of Echinoderms," has taken the opportunity of making some remarks which, at least partly, have somewhat the character of a personal attack on me. Being at that time on a scientific expedition to the Malay Archipelago, it was not until the middle of May last that I received the issue of NATURE containing that communication. In spite of Dr. Bather's chivalrous defence on my behalf, I think it desirable to send to NATURE an answer to Prof. MacBride's letter. This could not possibly be done then, however, as out there (at the Kei Islands) I had no access whatever to literature—not even to my own work. I had to wait until my return from the expedition, and therefore it is only now that I am in a position to send a reply to the statements made by Prof. MacBride a year ago.

Prof. MacBride first emphatically objects to the idea that the metamorphosis of Echinoderms might be an alternation of generations. It is not quite clear to me whether this is addressed to the reviewer or to the author, or perhaps to both of us. Dr. Bather has replied for himself to this objection. I may be allowed here to reply to it for my part, and shall do so simply by quoting what I did write.

On p. 124 of my work I state that in *Ophiopluteus opulentus* the postero-lateral arms remain in connexion after the young Ophiuran has been dropped, in the same way as it occurs in the larva of *Ophiothrix fragilis*. In *Ophiopluteus opulentus*, however, it appears that the larva does not perish after a little while, as doubtless happens to the Ophiothrix-larva. Some specimens show that *a new larval body begins to regenerate* from the postero-lateral arms. That we have here to do not simply with abnormal larvæ is evident from the fact that the long postero-lateral arms are perfectly normally developed, which could not be the case in an abnormal larva with the mouth and intestinal organs imperfectly developed, and accordingly unable to feed. Further, on p. 148 is said: "How far the process of regeneration goes cannot be ascertained; but in any case Pl. XX. Fig. 5 shows that it may go on so far as till the formation of a new mouth and œsophagus. It is also evident from the numerous nuclei seen in the anterior part of the new body that a vigorous growth is going on here, so that it would seem most probable that the process may continue the short while, until the new digestive organs are able to assume normal function—and then there seems to be no reason to doubt that a new complete and ultimately metamorphosing larva may be the result. Thus we would here have a *true case of metagenesis*, otherwise totally unknown in Echinoderms." Finally, on p. 149 I have said: "Of course, I do not mean to maintain that definite proof of this astonishing regeneration has been given. But the available material certainly indicates that it does take place. The problem most urgently invites closer investigation."

I think it clear from these quotations that I do not characterise the metamorphosis of Echinoderms as an altérnation of generations. On the other hand, if the regenerating larva goes on to metamorphose a second time, even Prof. MacBride certainly will have to regard this as a (of course quite exceptional) case of metagenesis in Echinoderms. The correctness of my observations is not to be doubted—the regenerating larvæ are at the disposal of any one who may wish to control my figures; and my conclusions, which are perfectly logical, I cannot agree to be audacious.

To my statement that since the larvæ of the more primitive Asteroids (the Phanerozonia) are devoid of a Brachiolaria stage, the sucking disk found in the larvæ of Spinulosa and Forcipulata must be a later acquired specialised structure, and accordingly the homology generally supposed to exist between the sucking disk of the Brachiolaria and the Pelmatozoan stalk only apparent, and the great part it has played in phylogenetic speculations unjustified, Prof. MacBride most emphatically objects: "No more rash statement could be made nor one more devoid of foundation. Modern Asteroids are divided into five groups, viz. Forcipulata, Valvata, Velata, Paxillosa, and Spinulosa. Nothing whatever is known of the development of any valvate or velate form, but the fixed stage is found not only in the development of the Forcipulata (which Dr. Mortensen arbitrarily regards as the most specialised forms) but also in the development of the Spinulosa (which all admit to be the most primitive group). In the Paxillosa, which include the British genera Astropecten and Luidia, and which, *mirabile dictu*, Dr. Mortensen appears to regard as primitive forms, the fixed stage is omitted. . . ."

I shall leave the strong expressions to Prof. MacBride and only comment upon his statement that "all admit" the Spinulosa to be the most primitive group of Asteroids.

Prof. MacBride will probably agree that among naturalists now living the following are the first authorities on Asteroids: W. K. Fisher, H. L. Clark, R. Koehler, and L. Döderlein. I have written to all of them, asking them to tell me (1) whether they have ever stated as their opinion that the Spinulosa are the most primitive Asteroids (I did not remember ever having met with such statements in their publications, but I might, of course, have been mistaken); (2) to inform me which group of starfishes they regard as the most primitive. All answered that they had never stated the Spinulosa to be the most primitive Asteroids. Prof. W. K. Fisher writes: "I think that the typical Phanerozonia such as the Astropectinidæ, Odontasteridæ, etc., are decidedly more primitive than the Spinulosa, meaning by that the Asterinidæ, Echinasteridæ, and Solasteridæ, to mention three of the families." Dr. H. L. Clark writes that he agrees perfectly with me "in considering the Asteropectinidæ as essentially primitive, and the Spinulosa specialised." Prof. Koehler writes: "Je crois, comme vous, que les types les plus primitifs doivent être cherchés dans les formes voisines des Astropectinidées, telles que le genre Hudsonaster et d'autres genres très anciens." Prof. Döderlein writes that he regards the family Asterinidæ as "die ursprünglichste aller Seestern-Familien." Among recent authorities on Asteroids, Döderlein thus is the only one who holds a similar view as to the classification of Asteroids as Prof. MacBride; but as he has never stated this opinion in any of his publications, neither Prof. MacBride nor I could possibly know anything thereof.

I may further mention that both Sladen and Ludwig, who, Prof. MacBride will probably agree, must also count as authorities on asteroid classification, likewise regard the Phanerozonia, not the

Spinulosa, as the more primitive. This opinion is also adopted by Hamann in "Bronn" and by Gregory in Ray Lankester's "Treatise on Zoology." Prof. MacBride alone, and, among late specialists in Asteroids, Perrier, have expressed the view that the Spinulosa are the more primitive of Asteroids. Is Prof. MacBride then not perhaps attaching somewhat too much value to his own opinion when he states that "all admit" the Spinulosa to be the most primitive group of Asteroids—with myself alone as an absurd exception ?

The question which group of Asteroids is the most primitive may not yet be definitely solved. If, however,—as *nearly* all admit—the Astropectinid forms are the most primitive, the conclusion is inevitably that the Brachiolaria, occurring—so far as evidence goes—only in the more specialised groups, the Spinulosa and Forcipulata, is a specialised larval form and its sucking disk a specialised, later acquired structure. Then this sucking disk is not homologous with the crinoid stalk, and its use in phylogenetic speculations is unjustified.

To Prof. MacBride's suggestion that my views would have some more value if I "had worked out with thoroughness the complete life-history of any Echinoderm," and to his protest against "the idea that those interested in Echinoderms agree with the over-estimate of the importance of trifling peculiarities in the structure of pedicellariæ in which Dr. Mortensen indulges" Dr. Bather has already kindly replied. In order not to make this belated reply too lengthy I shall then not take up these challenges at present.

TH. MORTENSEN.

Zoological Museum, Copenhagen.
November 22.

Rotary Polarisation of Light.

IN the second edition of Dr. Tutton's monumental work on "Crystallography and Practical Crystal Measurement," a question of some interest to crystallographers and physicists is raised in an acute form by a footnote at the bottom of page 1082, which reads :—

"Considerable confusion has been introduced into the subject of optical rotation by the fact that chemists, in their use of the polarimeter for the determination of the rotation of the plane of polarisation by optically active substances (chiefly liquids or solids in solution, but occasionally the solids themselves), have adopted a different convention, as regards the sign of the rotation, to that employed by physicists and crystallographers, who refer to the actual occurrence in the crystal itself. For instance, the right-handed quartz of the crystallographer actually rotates the plane of polarisation of light in the opposite direction to the so-called dextro-camphor of the chemist. The latter regards a rotation as right-handed or dextro when it appears clockwise to the observer looking through the eye-piece of the polarimeter. But the crystallographer regards himself as travelling with the beam of light, that is, as looking along the direction of propagation of the light: if the movement of the light in the crystal is like that of a right-handed screw, clockwise, the crystal is right-handed or dextro-gyratory, and if the light moves in left-handed screw fashion, anti-clockwise, the crystal is lævo-rotatory or left-handed. It is very important that this should be quite clear."

This question as to the precise meaning to be attached to the words "right-handed rotation" has been responsible for a certain amount of misunderstanding and confusion in text-books on mineralogy and physics for nearly a hundred years, and from Dr. Tutton's footnote it would appear that it is still unsettled.

Now the facts are simple. In 1813, the famous physicist Biot read a paper before the Institute of France[1] in which he described a number of experiments that he had made upon plates of rock-crystal cut perpendicularly to the axis of crystallisation. In carrying out this work Biot made the important discovery that there are two kinds of quartz—one in which the plane of polarisation is rotated to the right, while in the other the rotation is to the left. In carrying out these experiments Biot used a table polariscope, and adopting as a standard succession of colours that in which they ascend in Newton's scale, namely, red through yellow and green to blue, he found that a rotation of the analyser from left to right, that is in a clockwise direction, gave the standard succession for one kind of quartz, while an opposite rotation gave it for the other. The first rotation he spoke of as right-handed and the second, consequently, as left-handed. The experiments were subsequently carried out upon a considerable number of liquids and the convention of direction of rotation referred to was applied consistently.

In 1820, that is, seven years after Biot's discovery of right- and left-handed rotation of the plane of polarisation, Herschel read a paper before the Cambridge Philosophical Society[2] in which he announced his discovery that the direction of rotation of the plane of polarisation in quartz is indicated by the disposition of certain crystal faces.

Unfortunately, however, Herschel was not satisfied with Biot's convention, and he proposed to substitute for it one in which the observer was supposed to be looking along the beam of light in the direction in which the light was passing. While Biot, as it were, looked at an internally illuminated clock-face from the outside, Herschel preferred to look at it from the inside. Biot's right-handed thus became Herschel's left-handed rotation. Herschel, however, was consistent. He called the crystal which gave a right-handed rotation according to his convention, a right-hand crystal, and in giving the results of Biot's experiments on liquids, he changed the signs in order to bring them into accordance with his own convention. Thus according to Herschel cane sugar in solution rotates the plane of polarisation to the left.

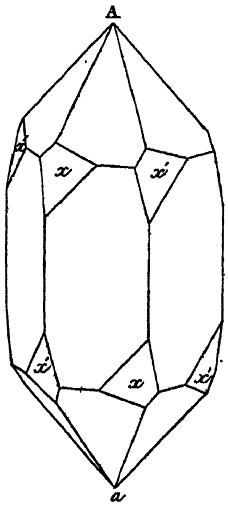

FIG. 1.—A right-hand crystal (Herschel).

Fig. 1 is a reproduction of the figure given in Herschel's original paper and reproduced in the article "Light" in the Encyclopædia Metropolitana (1830). In this article it is stated that the figure "represents a right-hand crystal." It is important to note here that in practically all modern books this figure illustrates a left-hand [twin] crystal. The confusion resulting from Herschel's attempt to substitute his convention for that of Biot was soon apparent.

In 1843 a book entitled "Lectures on Polarised Light delivered before the Pharmaceutical Society of Great Britain" appeared. This admirable little book of some hundred pages was written by Dr. Pereira. Now Dr. Pereira was evidently alive to

[1] "Mémoires de la classe des Sciences mathématiques et physiques de l'Institut Impérial de France (Année 1812)," Pt. I. pp. 263-4.
[2] Trans. Cam. Phil. Soc., vol. i. p. 43 (1821).

the danger of confusion arising from the existence of contradictory conventions such as those of Biot and Herschel, because, on page 86, he writes :—

"There are two varieties or kinds of circularly polarised light which have been respectively distinguished by the names of dextrogyrate or right-handed, and lævogyrate or left-handed.

"In one of these the vibrations are formed in an opposite direction to those in the other. Unfortunately, however, writers are not agreed on the application of these terms; and thus the polarisation, called, by Biot, right-handed, is termed, by Herschel, left-handed, and vice versa. There is, however, no difference as to the facts, but merely as to their designation. If, on turning the analysing prism or tourmaline *from left to right*, the colours descend in Newton's scale, that is, succeed each other in this order—*red, orange, yellow, green, blue, indigo*, and *violet*, Biot designates the polarisation as *right-handed*, or +, or ↗; whereas if they descend in the scale by turning the analyser *from right to left*, he terms it *left-handed*, or −, or ↖. Sir John Herschel, on the other hand, supposes the observer to look in the direction of the ray's motion. Let the reader, he observes, 'take a common corkscrew, and holding it *with the head towards him*, let him use it in the usual manner, as if to penetrate a cork. The head will then turn the same way with the plane of polarisation as a ray in its progress *from* the spectator through a *right-handed* crystal may be conceived to do. If the thread of the corkscrew were reversed, or what is termed a *left-handed thread*, then the motion of the head, as the instrument advanced, would represent that of the plane of polarisation in a left-handed specimen of rock-crystal.'

"I shall adopt Biot's nomenclature, and designate the polarisation right-handed or left-handed according as we have to turn the analysing prism to the right or to the left to obtain the colours in the descending order."

We have in these paragraphs a very clear and unambiguous statement of the two conventions. Biot's is finally adopted and used consistently throughout the book. It will be noted, however, that Pereira speaks of colours which succeed each other in the order, red, orange, yellow, etc., as descending in Newton's scale.

A second and greatly enlarged edition of Pereira's book, edited by the Reverend Baden Powell, appeared in 1854, after the author's death. In this edition the above paragraphs remain substantially the same, except that the words "the colours descend in Newton's scale, that is, succeed each other in this order, red, orange, yellow, green, blue, indigo, and violet," in the first edition, are replaced by these words in the second edition (see p. 253)—"The colours *descend* in the order of Newton's scale—that is, succeed each other in the order of the colours of their plates, reckoning from the central black as the highest point."

It will be noticed that the enumeration of the colours, red, orange, yellow, etc., has been replaced by the words "succeed each other in the order of the colours of their plates, reckoning from the central black as the highest point," so that we must seek further for information as to the meaning of the words "descend in the order of Newton's scale" as used in the second edition. And turning to page 256, we read :—

"Thus, suppose we turn the analyser right-handed, that is, as we screw up, the colours succeed each other, with a certain thickness of the crystal, in this order—*red, orange, yellow, green, purple, red* again, and so on, in the ascending order of Newton's scale, on the colours of thin plates, before given."

So that in the second and first editions, the word "descend" has contradictory and opposite meanings. In the first edition it refers to colours succeeding one another in the order, red, yellow, green, and blue, whereas in the second edition the word "ascending" is used to denote the same order of colours. The result is that while Biot's convention was given clearly and correctly in the first edition, and used consistently, that given as Biot's convention in the second edition is, unfortunately, not Biot's but Herschel's convention, but both are used, with the result that the student gets hopelessly puzzled.

In Dr. Tutton's book, in spite of the warning in the footnote quoted, the first and also the second editions have apparently been written consistently with the Biot convention. In the first edition, for example, at pp. 802-803 and in the second edition at pp. 1082-1083, it is stated that "a slight rotation of the analyser from the position for the violet transition tint, to the right (clockwise) or left (anti-clockwise) according as the crystal is right-handed or left-handed, causes the colour to change to red (first order). On the other hand, a rotation of the analyser contrary to the rotary character of the plates causes the violet transition tint to change to blue or green (second order)." This statement, it will be seen upon consideration, can only be true of the right- and left-handed crystals shown by Figs. 344 and 345

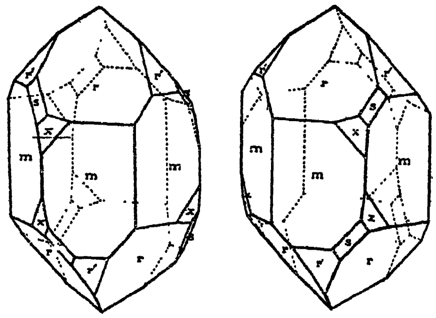

FIG 344.—Left-Handed Crystal of Quartz. FIG. 345.—Right-Handed Crystal of Quartz.

FIG. 2.

of the first edition (here reproduced in Fig. 2) and Figs. 311-312 of the second edition, upon Biot's convention. Upon Herschel's convention the words "right (clockwise)" and "left (anti-clockwise)" should be transposed in the above quotation.

Any attempt to revive Herschel's convention should, I think, be resisted. Simple experimental facts should be capable of description in clear and unambiguous language, and this, as has been shown, is not likely to be achieved so long as two conventions, in such a simple matter, are tolerated. The fact that Herschel himself brought his convention into line with crystallographic nomenclature by calling what is now universally accepted as a right-hand crystal, a left-hand crystal, has been overlooked. The crystallographic conceptions of right- and left-handed crystals are not likely to be changed now, so that the adoption of the Herschel convention by any writer will, or should, necessitate the definite statement that according to this convention a right-hand crystal is made up of left-hand quartz. Dana, it is true, in his "System of Mineralogy" gives Herschel's convention, but he accepts at the same time the usual definition of right- and left-hand crystals, so that a right-hand crystal, according to him, is left-hand optically. It should be remembered, however, that the last edition of Dana appeared thirty years ago. Later writers such as Miers, Johannsen, Duparc, and Pearce, and many

others, have not, however, followed Dana—a crystal right-hand crystallographically, is also right-hand optically with them. F. CHESHIRE.

Imperial College of Science,
South Kensington,
October 27.

I AM much indebted to Prof. Cheshire for stating so clearly the historic incidence of the confusion which has arisen in regard to the designation of the two types of optical rotation, as to which shall be called right-handed and which left-handed, due largely to the reversal of Biot's convention by Sir John Herschel, and to the similar reversion in the second edition of Dr. Pereira's book. Other investigators and experimenters have also adopted the reversal, for instance, Sir William Spottiswoode at the time he was president of the Royal Society, for on pp. 47-48 of his book, "Polarisation of Light," we read: "A right-handed ray is one in which, to a person looking in the direction in which the light is moving, the plane of vibration appears turned in the same sense as the hands of a watch." Moreover, if instead of using the polariscope as a table instrument one projects the phenomena on the screen, the picture there displayed is reversed exactly like a lantern slide, which has to be inverted in the lantern (the two spots in front at the top being brought to the bottom at the back), in order to get an upright picture on the screen. Thus, for example, in the mica-sector experiment of the late Prof. S. P. Thompson (pp. 1103-1104 of the second edition of my "Crystallography and Practical Crystal Measurement"), the black cross moves on the screen one sector to the left for a right-handed quartz crystal and to the right for a left-handed one; whereas on looking through the same instrument used as a table polariscope the movement is to the right for a right-handed crystal, in accordance with the Biot convention.

It is thus important to know the exact conditions of the experiment whenever the question of the correct discrimination of right- or left-handedness in the optical rotation of crystals is being dealt with. Further, the safest course, in the case of quartz, is to cut the section-plate to be used to afford the definite decision from a crystal which is clearly a single individual, and not a twin, showing the little *s* and *x* faces unmistakably, and this course was pursued by me in the preparation of my "Crystallography." As most in accordance with current practice (that of von Groth and Pockels, for example), and in rightful deference to Biot, the discoverer of the two optically active kinds of quartz, Biot's convention was used, in both editions of the book, a course which it is satisfactory to learn meets with the approval of Prof. Cheshire. The apparent opposite, on p. 1101, lines 7-8, is due to this being a projection experiment, the observer looking towards the screen along with the light rays; the direction here, however, really does not matter, as only the colour of the centre of the field is being referred to; even here, perhaps, it would be better in any future edition (they were not present in the first edition) to omit the words "from the point of view of the observer looking in the same direction as the light is being propagated," the text then conforming clearly with the Biot convention. On p. 1083, where a table experiment is being referred to, and the conditions are otherwise similar to those in the centre of the field in the case just referred to, there is no ambiguity, the Biot convention being clearly followed.

It was felt desirable to direct attention to the confusion which has so obviously arisen, and this was done in the footnote to p. 1082. Emphasis was attempted to be laid on the fact that, after all, the phenomena are due to the passage of the ray through the helical structure of the crystal, now so happily confirmed by Sir William Bragg's X-ray analysis of quartz, and that the observer does well to imagine himself travelling with the rays through the screw, in order to appreciate the cause of the rotation of the plane of polarisation or vibration of the light rays. The particular screw type, right- or left-handed, is the same, however, whether we regard the screw from one end of it or the other, whether we look along with or against the light stream; otherwise it would matter which side up the quartz plate were arranged, that is, which side were placed the nearer to any particular one of the nicols. But the optical effect, the rotation of the plane of polarisation or of vibration of the light rays, is, of course, what matters and what is so clearly different for the two different types of quartz helices, and it was my intention to retain and use the Biot convention for its directional (right- or left-handed) designation. The footnote in question is not sufficiently explicit, and must be amended in any future edition. Prof. Cheshire and the writer are, however, quite agreed on the facts, and that this Biot convention shall be the one employed, and I am grateful to Prof. Cheshire and to the editor of NATURE for affording me the opportunity of stating this. A. E. H. TUTTON.

Space-Time Geodesics.

IN his letter in NATURE of November 25, replying to mine which appeared in NATURE of October 28, Prof. Piaggio points out that the equations of Space-Time geodesics may be deduced by other methods than those of the calculus of variations, and suggests that, in some such way, it is possible to get over the difficulties to which I directed attention.

My criticism, however, was directed, not merely against the definition of Space-Time geodesics as *minimum lines*, but against all seeming definitions of them which start from ideas of measurement as a fundamental basis.

I must, however, in passing, warn my readers against what at first sight looks like a suggestion, though I have no doubt that it was not so intended by Prof. Piaggio, that Space-Time geodesics might be defined in terms of "*the osculating plane*."

If there were any strict analogy with the case of geodesics on surfaces in ordinary three-dimensional geometry, such an "*osculating plane*" would (apart from a line of intersection) have to lie in some mysterious region outside our Space-Time continuum altogether. Prof. Piaggio, however, I have no doubt, wishes to lay stress upon the equations he obtains.

I was of course aware that the *equations* of Space-Time geodesics could be arrived at by various analytical devices; but how much better off does this leave us? Consider, for example, the simple Space-Time analysis as given by Minkowski and see what it implies.

In the first place, it implies a set of co-ordinate axes x, y, z, and t, which are themselves *geodesics*.

How are these particular geodesics to be defined?

They cannot be defined as minimum lines, for they are not minimum lines; and we cannot use our co-ordinate system to define them, since we are now contemplating how the co-ordinate system can be set up.

In the second place, the co-ordinate axes are supposed to be *normal* to one another. How is this *normality* to be defined? It is to be remembered that *normality* in Space-Time theory is a wider conception than normality in ordinary geometry; since in the former we have lines which are "*self-normal*" (or what I have called "optical lines"), in addition to other rather curious features.

In the third place, the co-ordinate axes are supposed (if I may so express it), to be capable of graduation in equal parts. How is this graduation to be theoretically arrived at, and how are we to compare lengths, say along the axis of x, with lengths in some other direction?

It thus appears that we are reasoning in a circle if we attempt to give an analytical definition of Space-Time geodesics on such a basis.

The employment of generalised co-ordinates does not free us from difficulties, for, if it gets us out of one difficulty, it brings in another in its place.

Thus, for example, if the "graduations" were made according to arbitrary scales, the expression for the length of a Space-Time interval would contain functions the form of which would depend upon the arbitrary character of the scales employed.[1]

Again, if measurement of intervals be regarded as a fundamental conception, what is one to make of a case where

$$(x_1 - x_2)^2 + (y_1 - y_2)^2 + (z_1 - z_2)^2 - (t_1 - t_2)^2 = 0,$$

in which (x_1, y_1, z_1, t_1) and (x_2, y_2, z_2, t_2) are the co-ordinates of two Space-Time points?

It must not be supposed that in raising these objections to the ordinary methods of treating this subject I am concerned only with destructive criticism.

My own answers to these difficulties are to be found in my published work.

In conclusion, I must thank Mr. Rogers for his very interesting letter published in NATURE of November 25; which, however, does not call for any special reply.

ALFRED A. ROBB.

Cambridge, November 27.

[1] This is the same sort of point which would arise, for instance, in thermodynamical theory by using some arbitrary scale of temperature instead of the thermodynamic scale.

A New Type of Electrical Condenser.

SINCE an electrical condenser is a device for storing electricity, it follows that a secondary battery is a condenser—obviously of very large capacity as compared with the electrostatic type of condenser. Arguing from this point of view it appeared to the writer that, by a suitable arrangement of pasted lead grids immersed in dilute sulphuric acid and connected in circuit with an alternating current, it should be possible to obtain the characteristic effect of an electrical condenser, namely, a phase advance of the current relatively to the terminal potential difference.

FIG. 1.

A large number of tests have borne out this conclusion and it may be of interest to readers of NATURE to show an oscillogram of the effect (Fig. 1). The oscillogram was taken during a test on a cell consisting of grids pasted with red lead and immersed in dilute sulphuric acid. The temperature of the electrolyte was about 86° C., the frequency of supply was 3·5 cycles per second, the current density about 0·75 amperes per square inch of grid and the r.m.s. value of the terminal pressure was a little more than 2 volts. There was practically no gassing of the cell during the test.

If the fundamental of the potential wave is determined it will be seen that there is a large angle of phase advance of the current on the pressure. There is one other interesting point noticeable in the oscillogram, namely, the potential difference of the grids remains relatively very small during a large portion of the current wave. When the current wave has passed its maximum value the pressure quickly rises to a maximum and then falls to zero at about the same moment as the current reaches its zero value. The process is then repeated during the next half of the current wave.

T. F. WALL.

Edgar Allen Research Laboratory,
The University, Sheffield, November 25.

[AN engineering contributor to whom we have shown Dr. Walls' interesting letter writes: "It has been well known to electricians for the last thirty years that an electrolyte with metal plates in it will act as a condenser. These devices are called electrolytic condensers and are used in every-day work. They generally consist of aluminium plates immersed in an electrolyte, but iron plates in a solution of soda are sometimes used. They are useful for getting currents which lead in phase the supply voltage. Dr. Gunther Schulze carried out an extensive series of tests on electrolytic condensers at the Reichsanstalt in 1909. See *Elektrotechnik und Maschinenbau*, 'Kondensatoren Grober Kapazität' (vol. xxvii. p. 247, 1909)."—EDITOR, NATURE.]

Sex of Irish Yew Trees.

AFTER extensive inquiry up and down the country, I have so far failed to come across any example of the Irish Yew bearing male flowers. All the trees examined in private gardens and in cemeteries and churchyards have been of the berry-bearing or female sex.

I have now a number of young plants raised from the berries of the Irish Yew (*Taxus fastigiata*) fertilised by pollen from the English variety (*Taxus baccata*). These show a graded series from the spreading English type to the erect Irish form.

Growth is so slow, however, that it will be some years before it will be possible to ascertain the sex of these plants; meanwhile, I should be glad to know through the readers of NATURE any case of a male Irish Yew.

If, as is believed, the Irish Yew trees now growing in England have all been propagated by cuttings from the mutational Irish form, which first appeared in Co. Fermanagh, Ireland, more than a hundred years ago, this would explain the fact that they are all of the female sex. On the other hand, it is desirable to ascertain whether any linkage originally existed between erect habit of growth and female-ness in the mutational Irish variety.

Further, if any male example of the Irish Yew can be discovered it would be desirable to test the effect of fertilising the female Irish Yew by Irish pollen.

C. J. BOND.

Fernshaw, Springfield Road, Leicester,
November 28.

The Physiography of the Coal-Swamps.[1]

By Prof. PERCY FRY KENDALL, M.Sc., F.G.S.

THE subject of Coal Measures geology has been discussed piecemeal in innumerable papers and memoirs, so that an inquirer may well be appalled at the mass of facts and of often conflicting deductions with which he is confronted. Indeed, it is surprising to discover how fundamental are some differences of opinion which exist.

Among the questions in the answer to which doctors have differed there is, I imagine, none more fundamental than this:

Were coal seams simple aggregations of plant remains swept together by the action of water—a process of accumulation which the learned call allochthony; more simply by drift; or were they formed, like peat, by the growth of vegetable material in its place—the process of autochthony?

I do not intend to labour the answer to this question. Categorical arguments in favour of the growth in place origin of the coal-forming vegetation are on record, and they have never been as categorically answered. Many arguments in favour of the drift theory seem to me clearly to have arisen from confusion between cannel and true coal. This distinction is again fundamental. True coal-seams are characterised by:—

(1) Wide extent.
(2) Uniformity of thickness and character over extensive areas.
(3) Freedom from intermingled detrital mineral matter.
(4) Constant presence of a seat-earth or rootlet bed.
(5) Entire absence of remains of aquatic animals within the seam.

Substitute affirmatives for negatives, and negatives for affirmatives, and the characteristics of cannel are as truly set forth.

THE ABERRATIONS OF COAL-SEAMS.

Having got our coal-swamp clothed with vegetation, and the coal-forming materials accumulating, let us next consider the various interruptions of continuity and the aberrations to which it is liable. These interferences may be either contemporaneous with the accumulation of the materials, or, as one may say, posthumous.

Prominent in the category of contemporary interferences must be put the phenomena of split-seams. A split-seam is the intercalation into the midst of the coal of a wedge of sandstone, shale, or the like, in such wise that the seam becomes subdivided by intervening strata into two or more seams. The most notable split-seam in Britain is the famous Staffordshire Thick Coal. Jukes showed that this magnificent seam, 40 feet thick at its maximum, is split up into a number of minor seams by wedges of sedimentary strata which aggregate, in a distance of $4\frac{1}{2}$ miles, a thickness of 500 feet. The explanation offered by that sagacious student of coal, Bowman of Manchester, might find here a typical application. Bowman supposed that a local sag occurred in the floor of the coal-swamp, resulting in the drowning of the vegetation and interrupting the formation of peat until the hollow was silted up and a new swamp flora re-established.

I now turn to a form of split-seam of extraordinary interest, which has received comparatively little attention from geologists though mining engineers must surely have a special comminatory formula to express their sentiments thereon. The first example that came under my notice was encountered in the eastern workings of the Middleton Main Seam, at Whitwood Colliery, near Wakefield. Thin intercalations of shale and other sedimentary materials, appearing at different horizons in the seam, were found to thicken gradually to the east concurrently with the gradual dwindling of the lower part of the seam. An exploration was then carried out. The bottom coal was followed, but it was found that though the underclay continued the coal disappeared, and was wholly lost for a short distance before it reappeared. The top coal rose over a steadily thickening shale parting, and disappeared into the roof of the workings, but boreholes proved that it was present above a parting which was, at the maximum, 29 feet thick. At the farther end of the heading the top coal came down and the integrity of the seam was restored. Two other transverse explorations have proved the same general arrangement on the same scale of magnitude and one or both margins have been traced for a long distance, enabling the interruption to be mapped continuously for about 8 or 9 miles and intermittently much further.

My first impression was that this was just a simple case of Bowman's "sag," until I observed that in every traverse the *upper element of the seam was arched while the floor was flat.*

Several analogous cases came under my notice before an explanation of this anomalous arching was reached. The explanation was found to lie essentially in the differential shrinkage undergone by peat-stuff in the process of forming coal, and, on the other hand, by any sand or mud which may have been deposited so as to replace a part of the peat.

Let us imagine a stream being diverted at flood time across a bed of peat and scooping out for itself a hollow channel which subsequently becomes filled with sediments, and afterwards the formation of peat continues, the peat plants creep out, and presently envelop the whole mass of sediments. When the beds consolidate there will obviously be very different contraction between the sands, muds, and the coal-stuff. The sands will scarcely contract at all, the muds will contract a good deal, the coal-stuff will contract very greatly.

Let us now return to the consideration of the plano-convex lens of "dirt" occupying a position between the upper and lower elements of the split-seam at Whitwood. On the sag explanation it should be convex downward, yet in this as in all other cases I have investigated, it is convex upward. The explanation is simple. Let us make our mental picture of the infilled channel in the peat a little more specific in detail. Let us suppose that the peat was 40 feet in thickness when the river commenced to cut its

[1] From the presidential address delivered to Section C (Geology) of the British Association at Hull on Sept. 8.

course across it; the channel we will say was, like most channels, deeper in the middle than at the sides, and in the middle actually cut through to the seat-earth. Then the channel silted up completely, so that a cast of its meandering course in sands or mud reaching 40 feet in thickness at the maximum, but much thinner at the margins, was formed; then the upper bed of peat formed to a further depth of 40 feet. The conversion of the peat into coal would reduce it to two beds, each, let us say, 2 feet in thickness at the maximum, enclosing the sediment with a proportionately smaller thickness in the eroded peat on either margin of the channel. The sedimentary mass would have the transverse section of a plano-convex lens, the convexity being downward, but when the peat under the edges of the sediment is condensed to one-twentieth of its original bulk the base becomes almost flat, and the unconsolidated mass of sediments adjusts itself thereto. Thus the curve, originally at the base of the mass, reproduces itself in the top of the mass, which was originally quite flat and now is curved. The lens of infilling has reversed its curvature.

When a seam is deeply eroded the only too familiar phenomenon of a "wash-out" is formed.

The most common abnormality is the occurrence of belts or patches of "proud coal" in which the seam swells up to twice or thrice its normal thickness—sometimes, though not always, by repetition of the whole seam or of the upper part, either by shearing or by overfolding.

It has been suggested that all the violent displacement and over-ridings are brought about by tectonic agency, and that they are thrust-planes. The localisation to a single stratigraphical plane should suffice to discredit this explanation. An amplification of the same explanation ascribes the displacements to a thrust with a movement from S.E. to N.W. and a common cause to the cleat or cleavage of the coal which is normally directed to the N.W. It suffices to refute this to remark that the wash-outs I have explored in the Yorkshire coalfield are aligned in four principal directions, so that if superposed they would give what may be called the Union Jack pattern, *i.e.* N.E.—S.W., N.W.—S.E., N.—S., and E.—W.

Moreover, if these so-called "wash-outs" are not due to the erosive effects of contemporaneous or sub-contemporaneous streams, but to flat-hading faults, any coal displaced should be presently found again without any loss whatever. That swellings and duplications of the seam occur we have already noticed, and such phenomena have been pointed to as evidence that there is "no loss" of coal in connexion with the so-called wash-outs. But losses and the gains by duplication do not, in fact, balance. A simple and convincing case is a wash-out in a thin seam, in which, by taking measurements of the thickness of coal present and the breadth of the barren area, I have been able to show that a gap with no coal for 210 feet is compensated for by only 35 feet of excess on the margin.

SEISMIC PHENOMENA IN THE SEAMS.

While the displacements and duplications are totally unlike those produced by faults, there are cases in which the seam appears to have been subjected to a stretching tension and to have broken under the strain. Along the zone of such a stretch great confusion is commonly found. Masses of sedimentary materials, of the coal seam, and slabs and seams of cannel commonly occur, besides a curious argillaceous substance unlike any natural rock with which I am acquainted. In its unstratified structurelessness it suggests a kind of consolidated sludge such as might be produced by violently stirring or shaking a quantity of not too liquid mud. Where the seam abuts against this stuff it presents usually a nearly vertical ragged edge, its bright and dull layers preserving their characteristics quite up to the contact.

The explanation I have offered is that all these disturbances which complicate the already complex features of wash-outs are the effect of the lurching of the soft alluvial materials by earthquake agency. Every predicable subterranean consequence of earthquake action upon unconsolidated alluvial deposits, such as the Coal Measures were, can be seen in the Yorkshire Coalfield. The lurchings, the rolling and heaving of sand-beds, the shaking to pulp of the muddy deposits, the rending and heaving of the peat, cracks in the peat, and cracks infilled with extraneous material passing through the strata; and lastly, though actually the first clue to the explanation, masses of sandstone in the form of inverted cones ("dog's-teeth," "paps," or "drops"), descending on to coal-seams, which I interpret as the deep-seated expression of the sand-blows that are the invariable accompaniments of earthquakes in alluvial tracts.

An earthquake sweeping across an alluvial plain beneath which lay a thick bed of water-charged peat overlain by laminated clay, and that in turn by sand and an upper layer of mud or clay, would throw the peat and its watery contents into a state of severe compression which would result in the bursting of the immediate cover of clay and the injection of water into the sand, and, probably, a large quantity of gas, converting it thus into quicksand. This in turn would eject water in the form of fountains through the upper muddy or silty stratum, producing sand-blows and craters on the surface. When the disturbance subsided sand would run back down the orifice into the funnel above the peat. These are the "drops." They are commonly flanged down the sides, showing that they were formed upon a line of crack. An earthquake not infrequently gives rise to permanent deformations of soft deposits either by the lurching of the surface and the production of permanent wrinkles, or by subterranean migration of quicksand so as to produce, here a sag or hollow, there a ridge or bombement. Mr. Myron Fuller's admirable account of the effects of the New Madrid earthquake of 1816 as observed one hundred years after the event, is full of the most interesting and suggestive observations, not the least so those upon the sand-blows and sand-filled fissures containing lignite—the sand having come up from a bed lying at a depth of not less than 80 feet—the elevated tracts, and the new lakes produced by subsidence.

THE "CLEAT" OR "SLYNES" OF COAL.

One feature of coal-seams I must discuss before I conclude, though it will not at first appear clear

that it can be brought within the title of this address —I allude to the cleavage or cleat or slynes of coal. If we look at a piece of coal this cleavage is very conspicuous, for, lying at right angles with the bedding, it gives the straight sides to the fragment. It is obviously not like the cleavage of slate, *a texture*, but it is a series of well-developed joints.

It is a vital element in the cleat problem that it is as well developed and as definite in direction in a flake of bright coal the $\frac{1}{100}$th of an inch in thickness as in a tree-trunk. While I was preparing this address I procured a slab of shale from the bed underlying the uppermost bed of the Millstone Grit. It bore numerous imprints of goniatites and a leaf of Cordaites, which, in its present condition of bright coal, varies in thickness from about $\frac{1}{50}$th down to $\frac{1}{150}$th of an inch in thickness. It is traversed by an even and regular cleat at intervals of about $\frac{1}{100}$th of an inch, disposed at an angle of about 35° to the length of the leaf. With great care it was possible to replace the slab in its original position and to determine the orientation of the cleat to be N.W.-S.E. This is not nearly the extreme of tenuity reached by well-cleated plant remains. I have specimens that are mere shiny films, and cannot, I should judge, exceed $\frac{1}{500}$th of an inch, yet they show well-defined and regular cleat. Further, it should be noted that the production of cleat was subsequent to the erosion of stream channels as well as to the production of phenomena on the margins of the wash-outs. Every pebble and flake of coal found in the displaced masses in these stream-casts has the cleat well developed, and in strict parallelism with the cleat of the adjacent undisturbed seam.

I have directed attention to the fact that cleat is quite independent of the joints traversing the shales and sandstones of the associated measures; whence I draw the inference that the cleat must have been produced prior to the jointing.

The reason for this early development of a joint system is easily found—the original peat, in passing into lignite, acquired a brittle consistency and a consequent disposition to joint. Indeed, the change of consistency is the effect of chemical change and loss, whereby the peat substance contracts. Hence when our Coal Measures were first laid down they would consist of a series of incoherent sands and muds, and this uncompacted condition may have persisted for a very long period, even surviving considerable tectonic disturbances. The peats, however, would be subject to changes entirely innate: the gradual loss of volatile constituents, or at least the resolution of the carbon compounds into new groupings and the conversion of the mother substance of the coal into lignite. In this condition the coal-substance would be brittle and liable to joint in response to the tensile strains set up by the contractility of the mass.

There are questions of very deep import concerned with the geographical direction of the cleat. The first reference to this interesting topic is, I believe, in a work, close upon a century old, by Edward Mammatt, entitled "Geological Facts to elucidate the Ashby-de-la-Zouch Coalfield," published in 1834. His fourth chapter, headed "On the polarity of the strata and the general law of their arrangement," contains these remarkable passages: "Polarity of the strata is a subject which hitherto has not been much considered. The extraordinary uniformity in the direction of the slynes and of the partings of the rocky strata seems to have been determined by the operation of some law not yet understood. . . . Wherever these slynes appear, their direction is 23° West of North by the compass, whatever way the stratum may incline. The coal between them has an arrangement of lines all parallel to the slynes, by which it may be divided. This is called the *end* of the coal."

In a paper in the *Geological Magazine* I commented on the fact that little had been written on the subject of cleat since Jukes's "Manual of Geology" (1862), in which he quotes a Nottinghamshire miner's remark that the slyne faced "two o'clock sun, like as it does all over the world, as ever I heered on," a generalisation to be remembered.

John Phillips corroborates the statement so far as concerns the coalfields of Northumberland and Durham, where he says it "runs most generally to the north-west (true)." The same direction, he says, prevails in Yorkshire and Derbyshire and also in Lancashire.

I have suggested a reason why coal should acquire a joint system anterior to, and independent of, that of the associated measures, but, while providing a jointing-force, that theory furnishes no explanation of the directional tendency of the cleat. This tendency must have been supplied by some directive strain —not necessarily of great intensity, but continuous in its operation.

In 1914 and since I have collected a great body of data regarding the direction of the cleat in coals and lignites in many parts of the world.

Cleat observations in the Northern Hemisphere show an overwhelming preponderance of a N.W.-S.E. direction in coals and lignites of all ages from Carboniferous to Pleistocene and from regions so remote as Alaska, Spitsbergen, the Oxus, Nigeria, and China. This direction persists through every variety of tectonic relations, but seems most regular in the largest and least disturbed fields.

Jukes's miner's astonishing statement that "the slyne faces two o'clock sun . . . all over the world" involves more than is at first glance apparent, for, as a friend has pointed out, that two o'clock sun must shine from a quite different compass-bearing in the Northern and Southern Hemispheres. Yet the data I have collected confirms generally the miner's declaration in the Southern Hemisphere as well as the North, though exceptions occur that may possess a deep significance.

Many of the southern coals have no definite cleat, but in such as do display a regular system there is a distinct predominance of the N.E.-S.W. direction, which has a curious inverse relationship with the N.W.-S.E. direction of the Northern Hemisphere.

I feel persuaded that the cause will be found in some relation to influences, tidal or other, dependent upon the earth's planetary rôle.

There is a negative aspect of the cleat question which brings it more clearly within the ambit of an inquiry into the physiography of the coal-swamps. I allude to the absence of cleat that characterises anthracite the world over. Upon this absence of cleat are attendant features that have been regarded as indicative of conditions prevailing during the

formation of the coal, and hence clearly within my terms of reference.

In the Memoir of the Geological Survey on the Coals of South Wales, it is pointed out that the anthracite condition, instead of being accompanied by a high ash-content—which is what might be expected if the ash ratio were determined simply by the reduction in the non-ash—is shown statistically to bear the reverse relationship. That is, the more anthracitic the coal, the lower the ash. From this it is argued that the anthracites of South Wales were formed of plant-constituents different from those contributing to the steam and house coals. This proposition gains no support from the study of the plants found in the associated measures, nor does it explain why the coals of other fields, composed in their various parts of very diverse constituents, do not exhibit the anthracite phase. But the ash question needs to be approached from another point of view. The ash of coal may, as I have shown elsewhere, be composed of three entirely distinct and chemically different materials. There may be (1) the mineral substances belonging to the plant-tissues; then (2) any detrital mineral substances washed or blown into the area of growing peat; and, finally, the sparry minerals located in the lumen of the cleat.

As to the first, I have long considered that the coal was in large measure deprived by leaching of much of its mineral substances; it is otherwise difficult to account for the almost total absence of potash. The second—detrital matter—is probably present in some though not in all coals; the high percentage of aluminium silicate is probably of this origin. But the third constituent—the sparry matter—may, both on *a priori* grounds and upon direct evidence, be assigned a very important rôle in the production of the ashes in most coals. When a coal with a strongly developed cleat is examined in large masses it is at once seen that the cleat spaces are of quite sensible width, and that they are occupied most commonly by a white crystalline deposit which may consist of either carbonate of iron or carbonate of lime, and there are also in many seams crystals of iron sulphide—either pyrites or marcasite. These sparry veins may be as much as $\frac{1}{10}$th of an inch, or even more, in thickness, and they clearly constitute the principal contributors to the ash. It has been suggested that they are true components of the original peat, a proposition to which no botanist would assent, and it appears certain that the veins consist of material introduced by percolation from the overlying measures, subsequent to the production of the cleat. If that be so, it then will follow that the amount of the material present in coal must be in some direct proportion to the available cleat space, and if there is no cleat neither will there be any vein-stuff to contribute to the ash. It should be pointed out that ordinary bituminous coal broken into minute dice and washed so as to remove any heavy mineral particles is found to contain a percentage of ash quite comparable with that of an average anthracite. It is to be concluded, therefore, that the variations of the ash contents of a coal are no indication of the plant-constituent of the coal.

I have sought to show how the concept of the Coal Measures with their sandstones, shales, and coal-seams accords entirely with what we know of modern swamps and deltas, and that just as each Coal Measure fact finds its illustration in modern conditions, so we may, inverting the method of inquiry, say that no noteworthy features of the modern swamps fail to find their exemplification in the ancient.

Even what may seem the most daring of my propositions—the seismic origin of abnormal "wash-outs"—finds, I cannot doubt, a full justification in what has been *seen* in the Sylhet region by Mr. Oldham, and in the Mississippi valley by Mr. Fuller, or in what can be *inferred* as a necessary subterranean accompaniment of these surface signs of great earthquake convulsions.

The Royal College of Science for Ireland.

THE scientific public cannot but feel grave concern that the Royal College of Science for Ireland is at present closed, and its students are scattered in temporary accommodation. All interested in applied science will realise that this is a serious state of affairs, both as regards Ireland's industrial prosperity and scientific progress.

The College was founded nearly sixty years ago. It came into existence in 1865 as the result of a Treasury Minute of that year, which converted an existing institution—the Museum of Irish Industry and Government School of Science applied to Mining and the Arts—into the Royal College of Science. Sir Robert Kane—well known as the author of "The Industrial Resources of Ireland"—was appointed its first Dean.

The College was at first housed in premises in St. Stephen's Green, and as early as 1869 it had earned considerable reputation for itself as a school of science. Thus, the Commission on Science and Art in Ireland, of which Huxley and Haughton were members, reported in that year, that—"In the Royal College of Science, Ireland possesses an institution which in the number of its professorships and general course of study is more complete as a pure school of science than anything of the kind existing in England or Scotland."

In its earlier years the College was under the administration of the Department of Science and Art; but in 1900 it was placed under the control of the newly created Department of Agriculture and Technical Instruction, a department which was largely the outcome of what was known as the Recess Committee, of which Sir Horace Plunkett was chairman and Mr. T. P. Gill secretary.

Under the enlightened administration of this Department, the College was greatly developed and extended, particularly in rendering it of more direct service to the industries and needs of the country. In the early days of the College, chief attention was devoted to such subjects as chemistry, physics, mathematics, geology, mining, engineering, and manufactures. Under the Department, however, not only were these activities extended, but also considerable developments were made in connexion with agriculture, which is the staple industry of the country.

With the expansion of the teaching of applied science on so wide a scale, the accommodation in the existing buildings rapidly became wholly inadequate. Accordingly, the provision of new quarters became imperative, and under Act of Parliament in 1903 a government grant was made for this purpose. The magnificent new buildings on the present site in Upper Merrion Street were thus made possible, and the foundation stone was laid by King Edward VII. in 1904. The buildings were opened by King George V. in July 1911, and in October of that year the College began work in its new laboratories.

The buildings (Fig. 1), which were designed by Sir Aston Webb, occupy three sides of a quadrangle, and the numerous laboratories and lecture-rooms are laid out in a manner leaving nothing to be desired. Neither care nor expense has been spared in making the buildings and equipment perfectly suited for the work of the College. Many years have been spent in their completion, and they are among the best in the British Isles at the present time. The laboratories are replete with the most modern appliances and accessories, and the machines and apparatus installed have been chosen for their excellence from the world's markets.

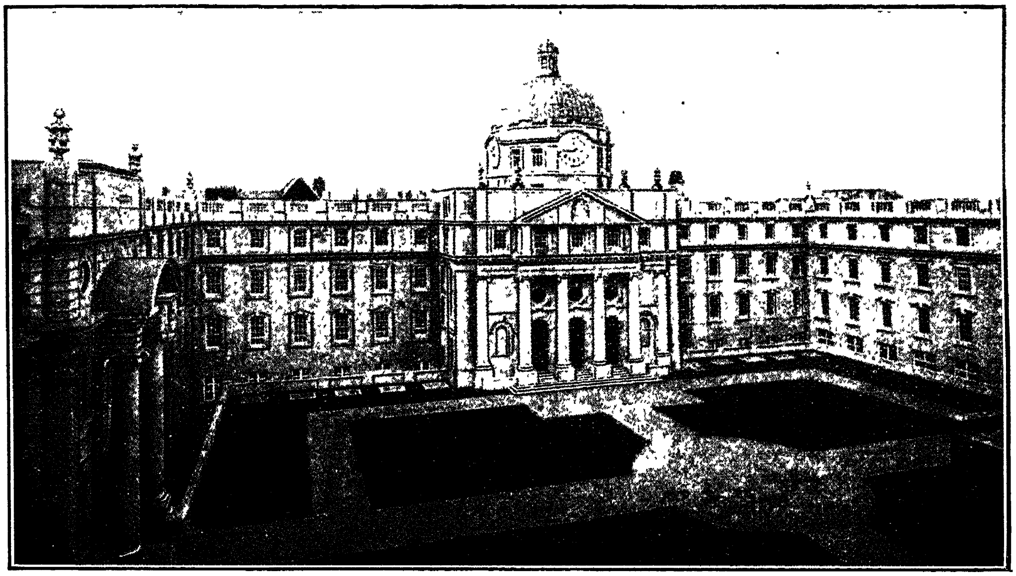

FIG. 1.—Royal College of Science for Ireland.

In short, the College possesses the great advantage that its buildings and equipment in every detail are up-to-date, and both have been thoroughly laid out with the definite object of providing the means necessary for dealing efficiently with the courses of education undertaken. The College buildings also provide laboratory accommodation for the important work of the Plant Diseases and Seed Testing Division, and the Agricultural Analytical Station of the Department of Agriculture.

For some time it had become apparent that the three-year course, which until 1911 had been required of the students taking the associateship, was inadequate to deal satisfactorily with a gradually extending curriculum. Accordingly, shortly after the removal of the College to its new home, all the principal courses were extended to four years, an alteration which has been amply justified in the light of the results which have been attained. Broadly speaking, the curriculum is now arranged so that the first two years are devoted to work mainly of a mathematical and purely scientific character, while towards the end of the second year, and during the third and fourth years, attention is devoted largely to the applications of science, and to the professional aspects of the several subjects of study.

The courses in all cases involve very considerable use of laboratories and workshops, and close co-ordination between tuition in theory and laboratory work has been worked out carefully.

The work of the College is organised in three faculties—those of agriculture, applied chemistry, and engineering. In addition, there are four-year courses of study, in experimental science and in natural science, leading to industrial careers. The College also provides courses in science subjects for students who intend to become teachers in the technical and secondary schools of the country, and it is thus the keystone of the Department's scheme of technical and scientific education throughout Ireland.

Students who have successfully passed through one of the full courses of study are awarded the associateship of the College. Associates of at least three years' standing may proceed to the fellowship of the College, which is awarded for meritorious original scientific research or for contributing otherwise in a marked degree to the advancement of science.

There are professorships in agriculture, botany, chemistry, engineering, forestry, geology, mathematics, physics, and zoology; and lecturerships in agricultural botany, agricultural chemistry, bacteriology, organic chemistry, physical and metallurgical chemistry, engineering, horticulture, mathematics, and physics. Among the past professors are many well-known names, such as — Sir Robert Ball, Sir William Barrett, Sir

William Thiselton Dyer, Dr. A. C. Haddon, Sir Walter Hartley, E. Hull, Dr. G. T. Morgan, T. F. Pigott, and Sir Wyville J. Thomson.

Following upon the establishment of the College in its new buildings, there has been a steady and progressive increase in the number of its students, and its several courses of study are becoming appreciated more and more fully throughout the whole of Ireland. Moreover, the past students have been winning success in the several fields of industry and education for which their courses have fitted them.

In the Faculty of Agriculture the scientific courses given at the College have been the basis of considerable improvement in agricultural practice in the country, for in the majority of cases the young Irishmen who have attended these courses at the College have found their way into the service of the Department of Agriculture as Agricultural Instructors, located in various rural districts, where they act as scientific advisers to the farmers. Others put their knowledge to account in the management of large farms and estates.

In the Faculty of Applied Chemistry many highly trained young men have been turned out and have found scope for their training as assistants and research workers in many chemical industries, such as the manufacture of dyes, explosives, and synthetic drugs.

In the Faculty of Engineering the increase in the number of students following upon the development of the new laboratories has been specially marked, and already the demands for admission are taxing the accommodation to its utmost. The majority of these students find employment with the large engineering concerns in the British Isles; and prior to the present condition of depression, there was a regular demand each year for capable students from some of the leading establishments. The output of the engineering and chemistry departments of the College should be of great and essential service to Ireland, if a policy of industrial reconstruction is undertaken.

The equipment of the College is excellently suited for active research in many directions. Indeed, already after a few years' occupation of the new premises, upwards of one hundred researches were in hand or had been carried out, many of them being on subjects of direct benefit to the industries of Ireland. While research thus holds a high place in its activities, the College is, nevertheless, specially noted for the thorough attention that is devoted to the effective teaching of its students. Its success is due to the devotion and energetic service of its able staff, as much as to the modern conditions under which their labours are carried out.

It would not only be a national calamity but also a matter of the greatest concern to progress in applied science if this great institution, that has taken many years of devoted service of its staff to bring to its present high standard of excellence, should be rendered unavailable for the young men and women of Ireland. It is, therefore, greatly to be hoped that the present difficulty will be but a passing cloud, and that the College will soon be permitted to reopen its doors, and will find its true place in the industrial development of Ireland.

Obituary.

SIR ISAAC BAYLEY BALFOUR, K.B.E., F.R.S.

ISAAC BAYLEY BALFOUR, son of the late Dr. John Hutton Balfour, professor of botany in the University of Edinburgh from 1845 to 1879, was born in Edinburgh on March 31, 1853. Educated at the Edinburgh Academy, then as now one of the foremost of British public schools, young Balfour proceeded to the University, in which he graduated as D.Sc. in the department (not yet a faculty) of physical and natural science. He also matriculated in the faculty of medicine, and while still an undergraduate in that faculty was so fortunate as to be attached to the party which in 1874 visited the island of Rodriguez to observe the transit of Venus.

Resuming his medical studies, Balfour graduated as M.B. with honours in 1877, and thereafter continued his botanical studies in the Universities of Strasbourg and Würzburg. In 1879 he was appointed professor of botany in the University of Glasgow, and in 1880 undertook botanical survey operations in the island of Socotra. In 1883 he obtained the degree of M.D., being awarded a University gold medal for his thesis, and in 1884 he was elected Sherardian professor of botany at Oxford and given charge of the Oxford Botanic Garden, becoming at the same time a fellow of Magdalen. In 1888 he was elected professor of botany in the University of Edinburgh, in succession to the late Dr. Alexander Dickson, and was appointed King's Botanist for Scotland and Regius Keeper of the Royal Botanic Garden. From these posts Balfour retired in March last after having held them, as his father did, for a period of thirty-four years.

If Balfour, as regards youthful environment, was fortunately situated, he showed at an early age that he had made good use of his opportunities. In 1874 Dr. J. D. Hooker, then director of Kew, considered one of Balfour's letters from Rodriguez sufficiently interesting for communication to the Linnean Society. Among the results of this journey we owe to Balfour a finished study of the genus Halophila and an important contribution to the natural history of the difficult genus Pandanus. The elaboration of the material secured during his visit to Socotra involved sustained study for nearly eight years; the result was a work that has already become a floristic classic. But Balfour's systematic interest was equalled by that taken in economic questions, and his Socotran studies enabled him to determine the sources of more than one famous drug of which the geographical provenance was assured though the botanical origin was uncertain. From the outset of his career he realised the importance of historical study in the field of applied botany.

Short though Balfour's tenure of the Sherardian chair was, the success with which he discharged its duties led to results of permanent advantage to Oxford and to botany. Under his care the historic "Physick Garden" regained its old consequence. The part he played in the provision of an English version of De Bary's Fungi, Mycetozoa, and Bacteria earned for him

the thanks of English and American students, who owe him besides a debt for his share in the foundation of the *Annals of Botany*; from the outset he served as one of the editors of this successful and important journal.

It was, however, the work accomplished by him as a teacher for a generation at Edinburgh that led Balfour to be regarded, with justice, as one of the foremost of British botanists. His personal charm enabled him to arrest the attention of his students; the lucidity of his discourse ensured the maintenance of that attention. But the reality of his success depended neither upon these natural accidents nor upon the variety and the precision of the knowledge which informed his teaching. It is to be accounted for rather by the wide sympathy which enabled him, as one who was at once an erudite natural historian and an accomplished experimental biologist, to combine all that was valuable in the older training to which he had been subjected in this country and in the newer methods which he had mastered abroad. To a still greater degree, perhaps, he owed his success to that sane outlook which enabled him to induce those he taught to regard botanical investigation and research, in the field, the cabinet, and the laboratory alike, as means to an end rather than as ends in themselves.

Balfour's work as Regius Keeper and as King's Botanist was actuated by the same philosophy. His study of the natural history of the plants under his care, while complying with the highest standard set in ecological and in systematic work, was undertaken with the object of mastering their cultural requirements. The success of his results in the technical field was largely due to the thoroughness of his scientific study.

The long-sustained and critical investigation of the members of the two great genera, Primula and Rhododendron, to which of late years Balfour devoted much of his scanty leisure, has given his name a permanent place in the annals of systematic study. The complexity of the problems he has had to face might almost justify a suspicion that in Balfour's case the difficulty of a subject was an added incentive to its study. However this may be, the fact remains that these arduous labours, though incidentally of extreme taxonomic value, have had as their primary purpose the rendering of assistance to horticulture in dealing with the accessions of new plant-forms during the past two decades from south-western China and the north-eastern Himalaya. It is because the object of his studies was the provision of technical help to the gardener, and not in spite of that fact, that the results attained are of such benefit to students of plant-distribution and plant-association.

Among the extra-official duties undertaken by Balfour were included willing services rendered to the Edinburgh Botanical Society, the Royal Society of Edinburgh, and the Royal Horticultural Society. Elected to the Linnean Society in 1875, he served on the Council during 1884–85; elected to the Royal Society in 1884, he served on the Council during 1892–94. In 1894 he was president of the biology section of the British Association at the Oxford meeting, and in 1901 was president of the botany section at the Glasgow meeting. An invitation to serve as president of the Linnean Society, in succession to Prof. Poulton, in 1916 was declined, and the intimation that his health was such as to preclude acceptance was one of the earliest to cause his friends disquietude.

In 1920 Balfour was created a K.B.E. in recognition of the great public services rendered by him during the war, his devotion to which had undermined his constitution. Among other honours bestowed on Balfour were the Victoria Medal of Honour of the Royal Horticultural Society, received in 1897, and the Linnean Medal—the highest honour the Linnean Society could offer—received in 1919. The wish then expressed by the latter society that Balfour "might long be spared to continue the work that has served its members as an example and an encouragement" has unfortunately not been fulfilled. By his death, which took place at Court Hill, Haslemere, on November 30 last, botanical science has lost a brilliant votary; his friends have lost one whose soundness of judgment was only equalled by his ready kindness and unfailing courtesy.

SIR NORMAN MOORE, BT., M.D.

THE medical profession is poorer by the death of Sir Norman Moore on November 30. Born in Manchester seventy-five years ago, he rose without influence and solely by his own exertions to be president of the Royal College of Physicians. He also earned a well-deserved reputation as an historian of British medicine. After a preliminary education at Owens College, he matriculated in the University of Cambridge from St. Catherine's College, whence in due course he graduated in arts and medicine, being afterwards elected an honorary fellow. He entered St. Bartholomew's Hospital in 1879 and remained in close association with it during the whole of the rest of his life. He served first as lecturer on comparative anatomy, later as demonstrator of morbid anatomy, and in due season as lecturer on medicine in the medical school, while in the hospital he filled in succession all the offices from house physician to consulting physician. He also acted for many years as dean of the school and warden of the college, living within the precincts of the hospital, and serving so zealously that for many years the annual entry of students exceeded that of any of the other hospitals in London.

During his years of residence in St. Bartholomew's Hospital, Moore laid the foundations of his renown as an historian of medicine. He wrote as many as 454 articles, dealing chiefly with the lives of medical men, for the "Dictionary of National Biography." He was instrumental in obtaining for the Royal College of Physicians the endowment of the FitzPatrick lectures, and himself gave two courses of the lectures, one on "John Mirfield and Medical Study in London during the Middle Ages," the other on "The History of the Study of Clinical Medicine in the British Isles." His knowledge of the subject and his work in connexion with it made him a worthy successor to Sir William Osler as president of the history section at the Royal Society of Medicine. More than thirty years of such time as he could spare from his other duties were devoted to the preparation of a history of St. Bartholomew's Hospital. The work was delayed by the war, but it appeared in two well-illustrated quarto volumes in 1918, and immediately became a classic.

The age and traditions of the Royal College of

Physicians appealed to Moore in the same way as did those of St. Bartholomew's Hospital. He filled all the usual posts with unfailing punctuality, was Harveian Librarian, and served in the office of president from 1918 to 1921. He was also the representative of the College at the General Medical Council. He had an intimate knowledge of the needs of medical education, and he took a leading part in that recasting of the medical curriculum which began in 1886 and is still in progress.

Moore's love of books and his knowledge of their contents were utilised by the Royal Medical and Chirurgical Society, where he filled the post of honorary librarian for many years. When the society was merged in the present Royal Society of Medicine, Moore, in conjunction with Mr. Stephen Paget, wrote the chronicles of the society from 1805 to 1905, with some account of the presidents.

In 1919 Moore was created a baronet. He was twice married, and is succeeded by his surviving son, Alan Hilary.

Current Topics and Events.

WHILE the rest of the world has been getting used to filling up the forms required by Customs authorities, and to awaiting with patience the delays involved in the examination by Customs laboratories of imported products that may prove to be dutiable, Great Britain has forgotten the very existence of such things, and their reintroduction, as a consequence of the Safeguarding of Industries Act, is regarded as little less than a revolutionary innovation by importers and their spokesmen in the House of Commons. It is clear from the debate which took place on Sir John Simon's amendment to the motion for an address in reply to the King's Speech, regretting the absence of any reference to the repeal of this Act, that opposition to the Act arises largely from its administration. Almost every speaker admitted the necessity of legislation to prevent the recurrence of the famine in magnetos, drugs, optical glass, dyes, and other essential commodities, which occurred in this country on the outbreak of war, but those who wished the Act repealed failed to mention a scheme by which this end could be achieved, probably because any attempt to do so would split up the apparently solid phalanx of opposition. To those who have the national welfare in mind, the troubles of Sir John Simon's trader, who had a consignment of potassium permanganate held up for two months by the Customs, will make slight appeal, and they would cheerfully see a few traders, who have no direct interest in industry and merely buy and sell, sacrificed, if by that means they could ensure the establishment in this country of highly technical industries in which skilled craftsmen and technical experts could be employed and the safety of the country in war and in peace assured. The difficulties which the operation of the Act places in the way of the importation of chemicals and instruments required by research workers, naturally evoke more sympathy than those of traders; and it is satisfactory that the Government was able to promise a joint inquiry by the Department of Scientific and Industrial Research and the Board of Trade into the progress actually made in the industries with which the Act is concerned. In the course of that inquiry these difficulties will no doubt be fully explored and means of dealing with them evolved.

THE needs of men of science in Russia have been referred to on several occasions in our columns, and we have suggested that the different groups of scientific and technical societies should concern themselves with groups of workers in their own departments. This has, we believe, been done in connexion with the Committee for the Relief of Russian Intellectuals, the president of which is Sir Paul Vinogradoff. There is an Engineers' Section Sub-Committee, with Sir Robert Hadfield as president, and this sub-committee has just made an appeal on behalf of Russian engineers and their families, who, not alone in the famine areas but throughout Russia, are undergoing terrible suffering and distress. If British engineers will help, many lives can be saved and the human energy and knowledge necessary for the reconstruction of Russia can be retained. Assistance is required for the provision of food and clothing. Food parcels may be sent to particular individuals, or names and addresses can be supplied to donors who prefer to send parcels direct. Remittances should be sent to the honorary treasurer, Mr. R. C. Griffith, 8 Victoria Avenue, Bishopsgate, London, E.C.2, who will be glad to give any particulars desired.

A SCIENTIFIC novelties exhibition will be held at King's College, Strand, W.C. (by kind permission of the College delegacy), from December 28 to January 10, in support of the Hospitals of London Combined Appeal. Members of the scientific staffs of the various colleges and schools of the University of London, as well as of university institutions having recognised teachers, are assisting with exhibits or demonstrations, and short lectures with experimental or lantern illustrations will be given by Profs. Bairstow, Sir William Bragg, Cheshire, Winifred Cullis, Flinders Petrie, Garwood, Gordon, Macgregor-Morris, Watts, Wilson, and many others. The exhibition will not be merely a display of objects of interest, but of the character of a conversazione, in which experiments and demonstrations will be going on continuously. It will thus be attractive to both old and young, and we hope it will bring a substantial sum into the fund for which it is being organised.

THE issue of *La Nature* for November 18 contains a summary of the recent International Congress on Combustible Liquids held in Paris under the auspices of the French Society of Chemical Industry. Prior to the opening of the congress, an exhibition was organised in which practically every phase of the petroleum and allied industries received attention. The several stages in the production and refining of crude oil were amply illustrated by an excellent

series of exhibits, including not only the various products manufactured, but also the plant and machinery employed both in the field and in the refinery. A special feature was the exhibition of different types of internal combustion engines in actual operation, burning those grades of fuel most suited to particular designs. The congress was opened by Prof. Sabatier, and the business transacted was of a most comprehensive nature, the industry being considered in both its theoretical and practical aspects. Undoubtedly the most important question raised at this congress was that of the necessity of adopting a uniform terminology to cover the enormous variety of combustible liquids now being marketed. At the present time the utmost confusion reigns in many cases where a name for a given product in one country implies a totally different product in another. Further, the varied methods adopted of testing these products for definite commercial purposes are often productive of results which, while suitable for one country, are quite ineffective for another. In order, therefore, to standardise both methods of comparison and the nomenclature universally applicable to definite products for specific purposes, an international commission has been set up, composed of delegates of the several countries represented at the congress. The importance of this work cannot be overestimated, particularly from the point of view of European markets, though it is to be hoped that representatives of the American petroleum industry will take a prominent part in the framing of the ultimate standards adopted.

DR. J. WALTER FEWKES, chief of the Bureau of American Ethnology, Smithsonian Institution, has recently returned to Washington from the season's archæological field-work on the Mesa Verde National Park, Colorado, and reports the unexpected find of an interesting prehistoric ruin to which he has given the name, "Pipe Shrine House." A mound of some magnitude in the neighbourhood of a reservoir called Mummy Lake was investigated, and a rectangular building about 70 feet square and one story high, which is accurately oriented to the cardinal points, and has a circular tower formerly 15 to 20 feet high, like a church steeple, midway in the western wall, was discovered. The tower was probably used for observing the sun as it rises in the east or sets in the west, in order to determine the time for planting and other events. In the middle of the building was found a circular room twenty feet deep and about the same in diameter in which were more than a dozen clay tobacco pipes, numerous stone knives, pottery, idols, and other objects. Pipes of this kind have never before been found on the Mesa Verde National Park; apparently after the rite of smoking they were thrown into the shrine. South of the building, which was evidently specialised for ceremonials, is a square room or shrine dedicated to the mountain lion, a stone image of which was found surrounded by water-worn and other strangely formed stones. A similar shrine in the north-east corner of Pipe Shrine House contains a small iron meteorite and a slab of stone on which is depicted the symbol of the sun.

THE juvenile lectures at the Royal Institution this Christmas will be delivered by Prof. H. H. Turner, whose subject is "Six Steps up the Ladder to the Stars." The first lecture will be given on Thursday, December 28, on "The Distance of the Stars," followed by "The Discovery of the Planet Neptune," "Photographing the Stars," "The Spectroscope and its Revelations," "Two Great Streams of Stars," and "The Size of a Star." The following are the lecture arrangements before Easter: On Tuesday afternoons, commencing January 16, there will be two lectures by Prof. F. G. Donnan on "Semi-Permeable Membranes and Colloid Chemistry," two by Mr. R. D. Oldham on "Earthquakes," two by Prof. A. C. Pearson on "Greek Civilisation and To-day," two by Sir Arthur Shipley on "Life and its Rhythms," and two by Prof. C. G. Seligman on "Rainmakers and Divine Kings of the Nile Valley." On Thursday afternoons, the Hon. J. W. Fortescue will give two historical lectures beginning on January 18, Prof. I. M. Heilbron two on "The Photosynthesis of Plant Products," Prof. B. Melvill Jones two on "Recent Experiments in Aerial Surveying," and Mr. Theodore Stevens two on "Water Power of the Empire." On Saturday afternoons commencing January 20, there will be two lectures by Sir Walford Davies on "Speech Rhythm in Vocal Music," two by Mr. J. C. Squire on "Subject in Poetry," and six by Sir Ernest Rutherford on "Atomic Projectiles and their Properties." The first Friday evening discourse will be delivered by Sir James Dewar on January 19 on "Soap Films as Detectors of Stream Lines, Vortex Motion and Sound." Succeeding discourses will probably be given by Sir Almroth Wright, Mr. C. F. Cross, Sir John Russell, Dr. A. V. Hill, Prof. A. S. Eddington, Dr. G. C. Simpson, Dr. M. R. James, and Sir Ernest Rutherford.

THE Journal of the Textile Institute has now nearly completed its first year under the new arrangement by which its pages are separately arranged and numbered under the three headings of Proceedings, Transactions, and Abstracts. The new form of the Journal should appeal to a wide scientific public, and the attention of biologists interested in the raw materials of plant or animal fibre may be directed to the very wide field covered by the abstractors and to the scientific character of the papers appearing in the Transactions. The Journal is now the medium through which a considerable amount of the scientific work carried on by the research associations of the woollen and worsted, the cotton and the linen industries, first sees the light. These newly formed research associations have naturally been busy surveying their wide fields for future effort, and the result has been that a number of very useful general summaries of the state of our knowledge of the chemistry, physics, and botany of the cotton hair have been published in the Journal by members of the staff of the British Cotton Industry Research Association. Preliminary results of new investigations upon the plant fibre also begin to appear, as, for example, the two papers by C. R. Nodder upon plant fibres, dealing mainly with flax and hemp.

ACCORDING to the last monthly circular of the British Cast Iron Research Association, the new director of research, Dr. P. Longmuir, is now formulating a scheme for the active prosecution of research work in several directions. Among the subjects now in hand are: iron suitable for moulds for glass bottles, these moulds being at present largely imported from abroad; and the magnetic properties of cast iron. The high silicon irons now found so useful in chemical industry on account of their high resistance to mineral acids are also to be investigated. Together with the American Testing Society, the question of the standardisation of cast-iron test bars is being examined, and it is hoped that an international specification can be devised. The Association is strengthening its library and reference facilities, and should appeal to a wider circle of ironfounders than its present rather limited membership, in view of the importance of cast iron to the national industries.

IN the Proceedings of the Royal Society of Edinburgh (June 1922) the general secretary—the late Dr. C. G. Knott—gives some interesting notes of a correspondence between the Royal Society of Edinburgh and the French Academy of Sciences about the priority of the discovery of the pilot cable (*câble guide*) for guiding ships into harbour in foggy weather. In 1921 the French Academy awarded a medal and a prize to W. A. Loth for various devices in connexion with navigation, and among these was the *câble guide*. The principle of this device, the Edinburgh Society states, is essentially that of the pilot cable invented by C. A. Stevenson and described by him in the Journal of the Society in 1893. Mr. Stevenson's invention consists in laying a wire or wires along the bed of the sea or of a river. Intermittent currents are sent along these wires, and suitable devices can be used on board ship to detect their proximity, and thus receive a warning of dangerous coasts, shoals, and so on. Stevenson's patent proves that the rough general principle was known so early as 1891, but this does not detract from the credit due to Loth for perfecting the system. The principle of the method is identical with that used by electricians in London prior to 1890 for locating the position of an underground cable.

A CHADWICK public lecture on "Relative Values in Public Health" was delivered by Sir Arthur Newsholme, on December 7. In the course of his lecture, which is one of a course, Sir Arthur Newsholme, after deprecating the undiscriminating call for retrenchment in public health expenditure, stated that it is necessary to adopt every practicable measure for educating the public, and the first step is to educate people as to the causes of evils. Historically, panic—fear of cholera and "fever"—had facilitated sanitation. In Sir Arthur's opinion, the appointment of paid inspectorates, thus introducing a new element into the implements of government, is necessary. Inspection has increased, extending from things and conditions of work and housing of persons, until we have now in view the ideal of hygiene advice and warning available for every member of the community. The inspections have educational value even more than in securing reform. Surveys are extended and systematised inspections, and are of value in arousing the community conscience and in securing the driving power needed for reform.

SIR WILLIAM H. BRAGG, Quain professor of physics in the University of London, has been elected a corresponding member of the Paris Academy of Sciences in the section of physics.

THE library of the Chemical Society will be closed for the Christmas Holidays at 1 P.M. on Friday, December 22, and will reopen at 10 A.M. on Thursday, December 28.

THE Indian Botanical Society took over ownership and control of the *Journal of Indian Botany* in October (1922). Prof. P. F. Fyson, who started the *Journal* in 1919 as a private enterprise, will continue as editor.

PROF. H. N. RUSSELL, of Princeton University, was presented with the Draper gold medal of the National Academy of Sciences of the United States of America at a dinner held in connexion with the New York meeting of the academy on November 15.

AT the meeting of the Royal Geographical Society on December 11, at the Æolian Hall, the French Ambassador, on behalf of the Société de Géographie of Paris, presented a gold medal to Prof. J. W. Gregory for his geographical work in East Africa. Prof. Gregory afterwards read a paper, the substance of which will be found on p. 826, on the results of his recent journey in the mountains of Chinese Tibet.

THE Swiney lectures on geology, in connexion with the British Museum (Natural History), are being delivered at 5.30 P.M. on Tuesdays, Thursdays, and Fridays, at the Royal College of Science, South Kensington, by Prof. T. J. Jehu, who has chosen as his subject "Fossils and what they Teach." Admission to the lectures, twelve in number, is free.

A STATUE of Prof. Adolf von Baeyer, presented by the Interessengemeinschaft der Farbenfabriken, was unveiled in the Botanic Garden of the University of Munich on October 20. Prof. Willstätter spoke on behalf of the University, and Dr. Duisberg on behalf of the Interessengemeinschaft, Prof. Seeliger for the Bavarian Academy of Sciences, and Dr. Lepsius for the German Chemical Society.

A COMMITTEE "to inquire and to report as to the method of charging for gas on a thermal basis" has been appointed by the Board of Trade. The members of the committee are as follows: Sir Clarendon Golding Hyde (*Chairman*), Mr. Arthur Balfour, Sir James Martin, Mr. A. A. Pugh, and Mr. W. J. U. Woolcock. Mr. W. H. L. Patterson, of the Board of Trade, will act as secretary to the committee.

IN a communication to the *Revue Scientifique* of October 28, Profs. Béhal, Haller, and Moureu urge the necessity of establishing some kind of protective measure to prevent German chemicals entering France. They point out that such measures have been established in the United States, England, Italy, and Japan, and they believe that prompt action of

a similar kind is necessary if French chemical factories are to remain in operation and French chemists in employment.

THE Bibliographic Institute for Auxiliary Scientific Work (1a Longridge Road, London, S.W. 5), established in 1917, affords assistance in the work of scientific research by supplying bibliographies upon subjects of any kind. The cost of such bibliographies depends entirely upon the range of work comprised in the special subject stated. Further information can be obtained from the English representative of the Institute at the above address.

A MEMORIAL window in Westminster Abbey in remembrance of Sir J. W. Wolfe Barry, past president of the Institution of Civil Engineers, was dedicated on December 7 by the Dean of Westminster. The window, which is in the nave, contains the figures of two angels holding tablets on which are inscribed the words "In Memory of John Wolfe Barry, K.C.B., F.R.S., Civil Engineer. Born 1836. Died 1918." Below the tablets are shields showing, among others, the arms of the Institution of Civil Engineers, of the University of London, and Sir John Wolfe Barry's personal arms.

THE annual meeting of the Mathematical Association will be held on Monday, January 1, and Tuesday, January 2, at the London Day Training College, Southampton Row. At the Monday meeting, which is to be at 5.30, Dr. S. Brodetsky will read a paper on "Gliding." On Tuesday there will be two sessions, one at 10 and the other at 2.30. At the first, a statement respecting the forthcoming report of the Sub-committee on the Teaching of Geometry will be made by Prof. E. H. Neville, and the following communications will be read: "The Uses of Non-Euclidean Geometry to Teachers," W. C. Fletcher; "Simple Geometrical and Kinematical Illustrations of the Plane Complex," Prof. R. W. Genese; and "A Certain Dissection Problem," J. Brill. At the afternoon meeting Sir Thomas L. Heath will deliver his presidential address, taking as his subject "Greek Geometry, with Special Reference to Infinitesimals"; and Prof. A. Lodge will read a paper on "Differentials as the Basis for Teaching the Calculus."

A USEFUL Catalogue (New Series, No. 5) of second-hand books on sale by Messrs. Wheldon and Wesley, Ltd., 2 Arthur Street, W.C.2, has just been issued. It contains upwards of 1200 titles of works dealing with geology, mineralogy, mining, coal gas, water, building materials, metal manufactures, etc.

MESSRS. DULAU AND CO., LTD., 34 Margaret Street, W.1, have just circulated a short, but choice, catalogue (No. 98) of Early Botanical Books. It is arranged under the headings "Herbals and Materia Medica," and "Early Agriculture and Gardening: Flora, Fungi, Orchids, Serial Publications, etc." Among the 356 works listed many are scarce.

THE Institute of Metals, 36 Victoria Street, London, S.W.1, has issued a name and subject index of the Journal of Institute (vols. i.-xxv.). The volume contains more than 20,000 entries and covers metallurgical work done during the period 1909–21. Copies can be obtained through booksellers or direct from the Institute of Metals.

Our Astronomical Column.

THE REPORTED NOVA IN LYRA.—In this column last week reference was made to the announcement of the appearance of a new star near the constellation of Lyra. The weather conditions for observing the object were not favourable, in this country at least, until the night of December 6, when observations were made at Greenwich, the Norman Lockyer Observatory in Devon, and at Armagh. All the observers reported that no bright star existed in the region of the supposed nova; in fact, photographs of the spectra of stars in that region down to the sixth magnitude, taken at the Norman Lockyer Observatory, did not reveal the presence of any star giving the characteristic spectrum of a new star. That a star of the first magnitude should dim so quickly in such a short period of time would be quite unique in the records of novæ, so it must be assumed that the observer was mistaken or the announcement incorrect.

Dr. A. C. D. Crommelin writes: "Widespread cloud prevented the announcement of the discovery of a Nova in Lyra from being tested at once, and it was thought advisable to circulate it with a caution, so that advantage might be taken of any clear intervals to search for it. December 6 was fairly clear at Greenwich, and it was quickly found that there was no strange orb visible to the naked eye in the neighbourhood of the given spot. Telescopic comparison was made with the B.D. chart for an area of 4 square degrees round the position without success. This search was conclusive, at least down to magnitude 7. Dr. Lockyer, Mr. Ellison (Armagh), Prof. Strömgren, and Dr. W. H. Steavenson also searched without success. The *Daily Mail* cabled to Bucharest and learnt that the Astronomical Society there knew nothing of the discovery. There is therefore practically no doubt that the announcement was the result of some mistake, the exact nature of which it is useless to conjecture."

LARGE FIREBALLS.—Mr. W. F. Denning writes:—"A large fireball appeared on November 24 at 6.40 P.M. which was seen from London, Manchester, and other places. It caused considerable flare in the sky for several seconds, and threw off a train of sparks at the later period of its flight. Comparing the various observations the radiant point is indicated at $87° + 34°$ and the meteor fell from a height of 71 to 26 miles. Its length of path was about 124 miles, and velocity 25 miles per second. It passed over the earth from the region about 12 miles west of Grimsby to Shrewsbury. The radiant point near Theta Aurigae is a fairly well-known centre of a minor shower observed during the last half of November."

Another great fireball appeared at about midnight on December 6 and caused a surprising illumination in the region of north Lincolnshire. A noise like thunder was heard two minutes after the disappearance of the meteor. The flight of the meteor was from east to west, but details of an exact nature are lacking.

Research Items.

WATER-SUPPLY IN CENTRAL AUSTRALIA.—Recent investigations in the heart of Australia have given it a more promising aspect than it had of old. In *Discovery* for December, Mr. O. H. T. Rishbeth, in discussing the economic possibilities of Central Australia, points out that a considerable area, about 150,000 sq. miles, has an average elevation of some 2000 ft. and rises to 5000 ft. in the Macdonnell and Musgrove ranges. But even in this more elevated part of the far interior the rainfall seems to be less than 10 in. a year and very uncertain in its occurrence. The future of Central Australia depends on the possibility of securing a satisfactory water-supply. A great deal could be done by the conservation of surface waters by means of dams, etc., but subterranean water must be the chief source. Many quite shallow wells seem to run freely with good water, but these can scarcely be looked on as inexhaustible. Artesian wells are promising and the water, though highly mineralised, is valuable for pastoral purposes. When the water-supply is assured and railway communications established, Mr. Rishbeth thinks this region has a future as a pastoral area. The carrying capacity and suitability of different parts for various animals must be tested; rabbits and dingoes must be systematically attacked, and stock routes with permanent wells opened up. Gold, mica, and wolfram are also known to occur, but difficulties of transport as well as lack of water have delayed mining.

WATER IN THE KENT COALFIELD.—The Kent coalfield was revealed by a borehole near Dover in 1890; since then no fewer than forty boreholes, comprising upwards of 90,000 feet of boring, have extended our knowledge of its area and depth. At present the Coal Measures have been penetrated by shafts at only four points; at no place have they been proved at a less depth than 800 feet below ordnance datum, yet the only important natural difficulty in their exploitation is the presence of large quantities of water in the overlying rocks. In a paper recently submitted to the Institution of Civil Engineers on "Underground Waters in the Kent Coalfield and their Incidence in Mining Development," Mr. E. O. Forster Brown has brought together many interesting facts concerning the quantity, quality, and local pressure of the water met with at different horizons, and has made suggestions, based on the results of his observations, which should prove of value in the development of mining and underground water supply in Kent. In descending order the water-bearing strata overlying the Coal Measures are, the Eocene, Chalk, Lower Greensand, Hastings beds, and estuarine sands of the Great or Inferior Oolite. During the last nine or ten years, 2 to 2½ million gallons of water per day have been pumped from Tilmanstone and Snowdown pits from the water-bearing beds below the Chalk. This water is allowed to run off at the surface. The author points out that the main faulting and fissuring follow the direction of the major tectonic folds, and that the water in the Oolite sands is divided into independent blocks by post-Jurassic faulting; he indicates the importance of a knowledge of this faulting in mining development. The water in the Oolite sands and in the Carboniferous Limestone below the Coal Measures probably comes from the French side of the Channel where these rocks are exposed in the Boulonnais.

ANTS IN RELATION TO PLANTS.—Myrmecophytism is dominated by the feeding habits of ants and their offspring. Until these are fully understood, it is scarcely possible to grasp the true ecological significance, and the origin of the extreme cases of apparent or true symbiosis, between certain ants and certain species of plants. In a recent and very readable publication ("Ants in their Diverse Relations to the Plant World," Bull. Amer. Mus. Nat. Hist. xlv., 1922, pp. 333-583: extracted from "Ants of the American Congo Expedition," pt. 4), J. Bequaert has brought together the varied and disconnected links of existing knowledge, and a perusal of this work only emphasises how necessary the close co-operation of entomologists and botanists is for the proper interpretation of many of the problems. The dispersal of seeds by ants is evidently an important factor in plant distribution. In Europe a great many grasses and herbaceous plants rely almost exclusively, or at least to a large extent, on certain species of ants for the successful dissemination of their seed. The cultivation of fungi by ants is one of the curiosities of biology, but we know that when the female of *Atta sexdens* starts a new colony, she carries in her infrabuccal pouch a pellet containing fungal hyphæ, with which to start fungus cultivation. She manures the mycelium until it attains a sufficiently luxurious growth to feed to the larvæ. The fungal parasites of ants, and the intracellular bacteria of these insects, also come in for discussion. A large part of the paper is devoted to a review of the myrmecophytes of Africa, and there is also included a bibliography of more than 1100 references dealing with ants in relation to plants.

RESEARCHES ON ORTHOPTERA AND DERMAPTERA.—Part 3 of the "Faune de France" has recently come to hand and is devoted to a description of the Orthoptera and Dermaptera of that country. M. Chopard, the author of this fascicule, is a well-known authority on these insects. In a compass of a little more than 200 pages he has provided a useful and profusely illustrated systematic handbook on the rich fauna inhabiting France. Mr. Morgan Hebard (Occasional Papers of the Bernice Pauahi Bishop Museum, vol. vii., pp. 305-376, pls. xxvi.-xxvii.) revises the species of the same orders of insects inhabiting Hawaii. It appears that the Gryllidæ are the richest in species of any family and number 30 kinds, of which 24 are probably native and 6 "adventive." There are no Phasmidæ, no native species of Acrididæ, and of 16 species of Blattidæ only 2 are native. Of the Dermaptera there are 12 species, one half of which are native. In the Annals of the Transvaal Museum (vol. 9, 1922, pp. 1-99, 4 plates), Mr. J. A. G. Rehn describes the Dermaptera and Blattidæ of the Transvaal and Natal. In the first-mentioned group only 9 species are recorded and none are new: among the Blattidæ there are 73 species of which 24 are new. In the *Bulletin of Entomological Research*, vol. xiii., part 2, 1922, Mr. B. P. Uvarov contributes a study of the grasshoppers of the genus Hieroglyphus and their nearest allies. They are well known in India as pests of rice and sugar-cane, but hitherto only one species, *H. banian*, has been considered noxious. It appears, however, that several species are probably injurious, and this article is written with the view of aiding in their discrimination and recognition.

SOME INDIAN LEECHES.—In his notes on some leeches in the Indian Museum (Rec. Ind. Mus., xxii. pp. 689-727, December 1921) T. Kaburaki deals with twenty-seven species and makes three new genera. In the single example of Foraminobdella, a new genus of the Herpobdellidæ, found in a stream in the Nilgiri District, Madras, the digestive tract opens to the exterior not only at the mouth and anus but also

by a pore in the mid-dorsal line of the fourteenth somite. The gut of Trematobdella, as described by Blanchard, also opens by a pore in the mid-dorsal line, and in Horst's *Nephelis dubia* there are two slender passages from the gut to the ventral surface where they open to the exterior.

PHILIPPINE CATTLE ROUND-WORM.—B. Schwartz records (*Philippine Journ. Sci.* xx. No. 6, 1922) observations on the life-history of *Ascaris vitolorum*, a parasite of cattle and of water-buffaloes in the Philippine Islands. The eggs develop rapidly—but if exposed to the heat of the tropical sun are quickly destroyed—and contain larvæ after about twelve days. Such eggs hatch in the intestine and the larvæ migrate *via* the liver and lungs back to the alimentary canal, as in the common round-worm of man, *Ascaris lumbricoides*, but appear to have a greater tendency than in the latter species to linger in the liver.

DISTRIBUTION OF OLIGOCHÆTA IN THE ANTARCTIC.—Two further parts of vol. vi. of the Australian Antarctic Expedition are contributed by Prof. W. B. Benham—Part 4 on the Oligochæta of Macquarie Island and Part 5 on the Unarmed Gephyrea. In the former four oligochætes are recorded—two species of Marionina, one Lumbricillus, and one Microscolex (Notiodrilus). In connexion with this last, Prof. Benham discusses the views that have been advanced to account for the present distribution of Oligochæta on the sub-Antarctic islands and concludes that this cannot be accounted for by polyphyly, floating rafts, carriage by birds, or by drifting seaweeds, and he is led back to the view, first put forward by Beddard in 1891, that the various islands and southern lands were once connected by land bridges. He believes that the former occurrence of chains of islands would suffice to explain the distribution of oligochætes, for the cocoons of these worms might then have been distributed on the feet of birds, and the pelagic larvæ of some of the littoral animals might have been able to survive for the short time necessary to pass across the intervening seas. He puts the origin of the Oligochæta "somewhere in the early Mesozoic epoch."

FUNGAL DISEASES OF RICE.—In the annual report of the Department of Agriculture of the Uganda Protectorate special attention is directed to local fungal diseases of rice. Early failures in the rice crop used to be attributed to unsuitable environmental conditions, but it is noteworthy that the symptoms of "blast" disease resemble the effect of drought and poor soil. This well-known disease, caused by *Piricularia oryzæ*, is reported for the first time in Africa. The disease appears to be widespread, not one of the plots examined being completely free. Both leaves and stems are affected, and when the latter are attacked at both nodes and internodes the plants may break down and the whole plot collapse entirely in bad cases. The ears are sometimes normal, but if attacked the grains are empty or only half filled. At no time has any diseased condition of the roots been observed. "Blast" appears to be the only major disease of rice in Uganda, but in one instance *Gibberella saubinetii*, a fungus with a bad record, has occurred. The supposed conidial stage of this fungus, a species of Fusarium, has not been proved to be connected with the Gibberella, and it is not pathogenic to wheat, rice or maize, on all of which it was found in the country.

PRAIRIE VEGETATION IN ILLINOIS.—A paper by Homer C. Sampson under this title, published as Article 16, in vol. 13 of the Natural History Survey of the State of Illinois, illustrates how American ecologists are attempting to record their main natural vegetation features before these are too much modified by man's activities. Sampson recognises the great importance of climate in determining the "centre of distribution" of the great prairie formation, which coincides roughly in its distribution with the area where the ratio of rainfall to evaporation lies between 60 and 80 per cent. As the prairie is met with farther from its natural centre of distribution, its stability becomes increasingly less so that it disappears before various edaphic and biotic influences. Sampson describes the origin of the prairie from the swamps and drier upland regions left at the close of the last glacial period. On these two soil types two different series of plant associations have followed, hydrophyte and xerophyte respectively in character, but both have ended in the prairie zone in the same association, dominated by *Andropogon furcatum*, the tall blue stem grass. Very striking must have been the appearance of the wide-rolling plains, clothed with this grass growing to a height of 10-12 feet, so that the earlier settlers could follow the movements of their cattle only by climbing to elevated ground and noting the agitation in the vast plains of grass. The author is to be congratulated on one unusual feature which terminates a memoir which is throughout admirably clear and concise. This is the bold attempt made to summarise the chief features of prairie vegetation in non-technical language so that the general public may learn the results of the study of one of the great natural assets of the state. This public should be interested in the author's statements as to the relative want of success that attends efforts to bring natural forest under cultivation as compared with the results of cultivation of prairie land which is normally richer in humus and less leached of its inorganic constituents.

WEATHER IN THE WEST INDIES.—Monthly and annual reports of the West Indies and Caribbean Weather Service have reached us for 1921 and a large part of 1922. The publication is carried out by Mr. Oliver L. Fassig, meteorologist in charge, at San Juan, Porto Rico, the service being in co-operation with the governments of the islands of the West Indies and of the adjacent coasts of Central and South America, under the controlling influence of the U.S. Weather Bureau. Daily rainfall returns are given from about 350 stations throughout the year 1921, and from more than 400 stations in the early months of 1922. In the latter year monthly mean and extreme temperatures are added. For each month the mean rainfall for the entire section is given based upon the reports from all stations observing, and usually a comparison is made with the normal. In 1921 the mean precipitation for the entire area was lightest during the month of April with a mean of 2·11 in. and a mean frequency of 8 days; the month of heaviest rainfall was October with 7·57 in. which fell on 16 days. The mean annual fall for the entire area was 54·32 in., and the mean number of days with rain was 144. In Jamaica the annual extremes at different stations ranged from 26 in. to 199 in., and in Trinidad from 60 in. to 156 in., the annual totals differing greatly, due to the varying topography. Observations are recorded of evaporation, water temperature, and earthquakes. The occurrence and movements of tropical storms are stated, warning of each storm being given by the U.S. Weather Bureau. Considerable development of the reports is evident, and the value of the data will in this way be further enhanced.

Physiological Aspects of Physical Measurement.[1]

By Sir JOHN HERBERT PARSONS, C.B.E., F.R.S.

PHYSICISTS too often forget that the basis of physical measurements is biological, for the so-called "outer world" only exists for us by virtue of the sensations it arouses in our bodies. Physical measurements are open to the errors of all human observations, and these vary in degree according to the type of observation. In all cases the observation is the formation of a judgment, based on the sensations derived from the stimulation of a sensory organ. Physiological experiments show that stimulation of some sensory organs gives more sharply defined responses than others. Thus, the responses to smell and taste are crude and vague; those to moderate cutaneous stimuli—touch and temperature—much better defined; those to auditory stimuli, still better, and those to visual best of all.

But even among the varieties of a given type of sensation various degrees of definition are met. Thus pain, though cutaneous, is crude like smell and taste; in vision, form sense is much more accurately defined than colour sense. Definition, indeed, varies as the biological differentiation of the sense organ.

Now, the most highly differentiated sensory organ is the eye, and the fovea is its most highly differentiated part. Experiments show that the greatest discrimination is met with in foveal stimuli. The highest degree of sensory discrimination is the appreciation of continuity or lack of exact continuity in two straight lines set end to end, as in the vernier. This may be called *linear identity*, and it is noteworthy that it has been adopted empirically by physicists in the vernier, balance, and other instruments. Physicists have been very ingenious in applying this criterion to otherwise apparently unsuitable measurements, as, for example, the measurement of temperature. But there are many physical measurements to which it cannot be applied, or at any rate has not been applied. Photometry is an example. Here we are measuring the brightness of two lights. By various devices the principle of identity or equality of sensations is made use of—thus utilising the only accurate psychological comparison—but the quality of the sensation to be adjudicated upon does not admit of the accuracy of linear identity. Even in homochromatic photometry we are comparing the brightnesses of two illuminated areas. As is well known, these areas react upon each other physiologically—by the process of induction or simultaneous contrast. Moreover, the judgment is affected by the previous stimulation of the retinal areas concerned (successive contrast). It is further vitiated by variations in adaptation.

Still more open to error are the comparisons of brightness of different coloured lights, heterochromatic photometry. Here the difference in colour acts as a very disturbing element. Yet by practice it is possible to attain almost as accurate results as in homochromatic photometry. But how can we judge of the accuracy of these determinations? In this particular instance we can have recourse to the fact that the critical frequency of flicker depends upon brightness and follows a definite mathematical law. The eye is extremely sensitive to flicker, so that the disappearance of flicker affords a very sensitive criterion. It has been found that the results obtained by the flicker photometer confirm the results obtained by the best so-called "equality of brightness" observations.

No matter how delicate the criterion there are still errors of observation due to imperfections of a biological nature common to all human observers and also to the so-called "personal equation" of the given observer. How are these to be eliminated? Recourse is had to mathematical theory. The basis of the theory of error, which is a branch of the theory of probability, is that small errors will be more frequent than large ones, very large ones will be practically absent, and the mean is the result of the mutual destruction or compensation of many small sources of error acting in opposite directions.

The kinetic theory of gases is built entirely upon this statistical foundation, and its success in explaining the physical properties of gases is strong evidence in favour of the statistical theory. There are several mathematical "averages or means," and much depends upon the choice of the suitable "means," which itself depends upon the frequency distribution of the observations. Graphic methods of eliminating errors are constantly used by physicists. One of the commonest is the method of interpolation, and the smoothing of the curves.

An interesting example of the opposite aspect of averages is the modern view of atomic weights. These are some of the most accurate physical measurements ever made and have been corrected by the best statistical methods. Many of them approximate nearly to whole numbers and there are many theoretical reasons for believing that they are whole numbers. Recent investigations, chiefly by Aston, have shown that the atomic weights hitherto obtained are themselves averages: that there are many so-called "isotopes," having almost if not quite identical chemical properties, but differing from each other in the number of their electrons and also in their true atomic weights, which are invariably integers.

I hope that this philosophical parenthesis suffices to show that even in the matter of physical measurements the physiological aspects of the subject must perforce be taken into account. But in dealing with illumination we are dealing not only with foveal vision, but also with peripheral vision and alterations of sensitiveness of the eye under different conditions of stimulation. It is well known that the foveal region of all parts of the field of vision alters least in sensitiveness under different intensities of illumination. It is, therefore, relatively stable, and observations founded on criteria derived from central vision are proportionately trustworthy. It is quite otherwise with the other parts of the field of vision. Here the sensitiveness of the retina increases enormously with diminution of the intensity of stimulation. This function of retinal adaptation, which is of such tremendous practical importance in the life of the individual and indeed of the species, interferes very seriously with the accuracy of scientific investigations. Physicists have been led astray by ignoring it, as, for example, in the so-called "deviations from Newton's law of colour mixtures" described by König.

Physicists, indeed, are so accustomed to deal with measurements of the highest order of accuracy, founded upon what I have called "linear identity" observations, that they succumb to two errors: (1) that of regarding these observations as of the supreme validity of mathematical abstractions; (2) that of regarding other observations, to which the "linear identity" criterion is inapplicable, as of far greater accuracy than is in fact the case. When the mistakes arising from these errors are too patent to be ignored, physicists are apt to exhibit an unwarranted impatience with the shifting sands of

[1] From the presidential address to the Illuminating Engineering Society, delivered on May 25.

biological science. The fact must, however, be faced that in all cases the observing instrument is a living organ and is, therefore, in a perpetual state of change. The rate of change is relatively slight in the most favourable cases, but rapid and complex in the less favourable. Physicists have been notoriously successful in so reducing the physical complications of experiments to a minimum that the problem nearly approximates to a mathematical abstraction, and, therefore, the highest degree of accuracy. Further advance is to be sought by greater attention to the biological complexities in order that they, too, may be subject to more complete control.

A mass of evidence has of recent years accumulated to show that in peripheral vision two mechanisms are simultaneously at work. Of these, one is chiefly concerned with vision under low intensities of light—what I have called scotopic vision. The end organ of this mechanism is the rods of the retinal neuro-epithelium. Photopic vision, or what may be called daylight vision, is chiefly carried out by the cones. The duplicity theory is so well established that it has even found its way into the writings of the physicists. The explanation and our knowledge of retinal adaptation depends upon these physiological facts. Since retinal adaptation plays a preponderant part in simultaneous and successive contrast its importance in photometry will be readily realised.

The Design of Railway Bridges.

A SUBJECT of great importance to the general public is the safety of the thousands of bridges by means of which our railways cross roads, rivers, and other railways. Probably it occurs to few railway travellers to consider the complexity of the design of each bridge they cross and the organisation required to inspect, test, and maintain every bridge in a condition suited not only to the traffic for which it was originally designed, but also to the increased weights and speeds which have since been introduced. It is but natural that differences of opinion should arise between the railway companies which have to pay for their erection and maintenance, and the Board of Trade which has to satisfy itself that they are safe.

The Ministry of Transport has recently carried out a series of tests on actual bridges, and has issued a report containing suggestions which appear to foreshadow regulations requiring railway bridges to be heavier and therefore more expensive. This report has naturally aroused great interest and caused no small concern among the bridge engineers of the leading railway companies. At the meeting of the British Association at Hull, the Engineering Section devoted a morning to a discussion of the problem. Unfortunately no representative of the Ministry of Transport took part in the discussion, but the railway companies were well represented and the speakers included the bridge engineers of the Great Western, North Eastern, and Great Central companies. Taken together the papers constitute a concise but fairly complete review of the present situation.

Mr. J. S. Wilson, who opened the discussion with a general review of the questions involved, showed that the difference of opinion between the companies and the Board of Trade is nearly as old as the railways themselves. In 1849 Torksey Bridge across the Trent was tested by the representative of the railway commissioners preparatory to the opening of the Retford and Lincoln line. The deflection of 1¼ inches with four locomotives and tenders on the centre of a span was considered excessive and permission to open the line was refused. The bridge had been designed by John Fowler who, with Sir Benjamin Baker, was responsible later for the Forth Bridge. He had followed the rules laid down by Fairbairn, and he suggested to the commissioners that some mistake had been made, but after further tests the latter persisted in their view that the stresses in the bridge were excessive. Finally, however, Fowler succeeded in convincing the commissioners that the girders, being continuous over the middle pier, were not stressed so highly as would otherwise be the case, and on his offering to reduce the weight of ballast on the bridge, the line was finally opened after a delay of three or four months. The subsequent history of the bridge is of interest. The bridge is still there; for forty-six years it was unaltered and carried all traffic satisfactorily; in 1896 it was strengthened by the addition of a longitudinal girder. These old iron bridges designed by Fairbairn and Fowler, which have stood the test of seventy years' wear and tear and are still in good condition, are powerful arguments in favour of the view that bridges built on the same assumptions will be perfectly safe.

There are many difficulties, however, in the calculations and assumptions involved in the design, in allowing for the effect of impact due to the fact that the load is a live one, that is, not a stationary load, and in allowing for the effect of sleepers, rails, and ballast in strengthening the structure, distributing the load, and damping out the effects of impact. It is here that some doubt arises as to whether the intentions of the Ministry are correctly interpreted by the railway companies; it is useless to specify a factor of safety or a working stress unless one also specifies how the stress or factor is to be calculated or determined. The bridge designer may employ what appears to be a low factor of safety because he knows that the actual stresses are less than those calculated by the simple conventional methods usually adopted and that his actual factor of safety is consequently much greater. If a high factor of safety is specified, then it is open to the engineer to modify not his design but his methods of calculation so as to take account of the various strengthening factors usually neglected, and thus obtain a lower calculated stress and a higher factor of safety than would be given by the usual semi-empirical method.

One speaker in the discussion advocated making full-scale tests on old bridges which were being replaced; these could be re-erected and thoroughly tested, if necessary to destruction. All the speakers deprecated the premature promulgation of rules which would lead to heavier and therefore more expensive bridges, but urged that present practice should be followed until systematic research has been carried out and far more knowledge of the subject obtained than that on which the Ministry of Transport are proposing to act.

In their attitude towards riveted structures of iron and steel, engineers may be divided into pessimists and optimists, and Mr. Wilson's experience showed that the greatest optimists have been those most closely associated with the maintenance or actual construction, who would certainly be the first to detect any indication that the bridges were showing signs of weakness.

An engineering student is always taught that the stress produced by a live load is double that produced by the same load when steadily applied. This

assumes, however, that the live load is suddenly applied. If the time taken to apply the load is comparable with the period of vibration of the bridge, this is no longer true, and however fast a train is travelling the time taken to apply the load is considerable, and it is not surprising that actual measurements of deflection show that the stresses due to a moving train are in many cases but little greater than those due to the same load when at rest.

One speaker in the discussion at Hull emphasised the importance of minimising corrosion and looked forward to the possible use of stainless steel for bridges; in the meanwhile he had great hopes of the cement gun, by means of which a thin coating of cement is applied to the iron work.

A paper by Mr. J. S. Wilson and Prof. B. P. Haigh dealt very fully with the influence of rivet holes, not only in bridges but in steel structures in general. This is of importance in the present controversy because of the uncertainty of the allowance to be made for the rivet holes in calculating the stress due to any given load. Calculation indicates that very high stresses should occur in the neighbourhood of rivet holes, but from a large number of experiments the authors came to the conclusion that "the metals used in practice have a ductility and other qualities which render them able to eliminate or accommodate these high stresses."

The various papers read and the remarks made by the speakers in the discussion all tended to show that the actual stresses occurring in bridge work are considerably lower than those usually calculated, and that past and present practice allows an ample factor of safety.

The Alps of Chinese Tibet and their Geographical Relations.[1]

By Prof. J. W. GREGORY, F.R.S., and J. C. GREGORY.

SOUTH-EASTERN Asia is a region of interesting geographical enigmas which deal with the contrast between south-eastern and south-western Asia, the eastern prolongation of the Himalaya, the place of the mountains of south-western China in the mountain system of Asia, and the remarkable arrangement of the rivers of south-eastern Tibet, which has been described as one of the most extraordinary features of the earth's land surface. These problems are intimately connected with the formation of the basin of the Indian Ocean.

"Seek knowledge," said Mohammet, "even if it is found in China," and in accordance with that injunction of the Prophet the authors landed at Bhamo on the upper Irawadi, 50 miles from the Chinese frontier. This port of departure was selected in obedience to the principle of the Burmese proverb that an old road is a fast road; for the road from Bhamo to the Treaty Port of Tengyueh in south-western China is one of the trade routes of Asia which has been used since prehistoric times. At Tengyueh the Indians who had accompanied the expedition over the frontier mountains were sent back, a Chinese staff being engaged; permission was obtained to proceed to Likiang, the administrative headquarters near the borders of Chinese Tibet. As part of this road was across unsurveyed country in which brigandage was rife, the authorities insisted on the money of the expedition being sent on either by draft or along the main road.

The expedition arrived at Likiang before its money, and a further check was threatened by the refusal of the magistrate to allow the expedition to proceed further north. This decision was found to be in obedience to instructions from the provincial capital, but the magistrate of Likiang ultimately agreed to let the expedition proceed, provided he had no further instructions from the capital, on the receipt of a letter stating that the travellers were going on in spite of his warning and entirely at their own risk. Meanwhile a Chinese merchant in the city had agreed to advance half the amount of the draft, and as soon as this was paid the expedition hurried northward into Chinese Tibet to get beyond recall.

The path taken descended from the plateau into the valley of the Yangtze-kiang where, though 2400 miles from the sea, it is still a great river, and was then in high flood owing to the melting of the Tibetan snows. The structure of this valley and of its two parallel neighbours, the Mekong and Salween, was studied in a series of journeys along these rivers and over the mountains between them. The inhabited districts along the Salween were smitten with famine owing to the failure of the previous harvest, and work there was impossible. The range of Kagurpu with its pyramidal snow-clad peaks and its great glaciers was inaccessible, as its crest is the forbidden frontier between Chinese and autonomous Tibet. Hence for a study of the mountain structure of this region the expedition turned eastward to the peaks and glaciers between the Mekong and the Yangtze-kiang, crossing passes from 16,000 to 18,000 ft. in height. Bad weather frustrated the attempt to explore the glaciers of Peima-shan and heavy floods hampered the return march to Likiang. Wide tracts of country around Tali-fu, the former Muslim capital which had withstood a siege of eighteen years during the Civil War of 1855–73, were flooded owing to the abnormally heavy rains. The caravan had to enter the city by climbing over the city wall, as the north gate was closed to keep out the mischievous spirits from the north which had brought the excessive rains that were threatening the country with famine. From Tali the expedition returned by the main road across Yunnan to the Irawadi in Burma.

The observations made during the journey show that the geography of Chinese Tibet is the result of mountain formation at two distinct periods. The deep valleys with their intermediate ranges, which are the most conspicuous topographic features, are the result of mountain movements of the age of the Coal Measures. These ancient movements gave the country a geographical grain trending north and south, and the Indo-Malayan mountains have been formed by the excavation of valleys along the weaker layers of the grain. Mountains belonging to a relatively modern date have been formed contemporary with the upheaval of the Alps and Himalaya. The high peaks of Chinese Tibet rising over 24,000 ft. in height are due to these later uplifts. The main axis of the Himalaya passes through Chinese Tibet and is probably continued through the Nan-shan of southern China to the Pacific. The Burmese and Malay mountain arcs, which are the same age as the Himalaya, represent a loop to the south of the main mountain axis like the Persian loop in south-western Asia and the Apennine loop in Europe. The great rises on the floor of the Pacific, which reach the surface in the Hawaiian Islands and the coral islands of Polynesia, are probably the continuation of these two mountain lines, being like them due to the pressure interacting between the northern cap of the world and the tropical or sub-tropical zone.

[1] Substance of a paper read before the Royal Geographical Society on December 11.

The enigma of the three parallel rivers is explained as due to their valleys having been worn out along clefts through which the drainage from south-eastern Tibet was enabled to escape through the mountain rim of Chinese Tibet. This rim had been formed by the Himalayan movements which were due to the intense compression of the crust; on the relief from that pressure the mountain ranges were broken by transverse clefts, and large blocks sank between a network of fractures. The basins formed by these subsidences gave the rivers great powers of enlarging their channels and thus of excavating the deep steep-sided valleys which are now the most conspicuous features in the topography of south-western China.

The Present Position of the Whaling Industry.[1]

WHALING has been practised as an industry for some centuries. The pursuit of the Atlantic right whale was carried on in the Bay of Biscay at an early date, and was active at least so long ago as the twelfth century. The Greenland right whale was hunted in three areas, at successive periods, at first off Spitsbergen from about 1610, when few Atlantic right whales were left, then in Davis Straits from about 1719, and finally in the North Pacific and Bering Sea from about 1840. The sperm whale, which occurred in the whole of the tropical belt, though by no means restricted to this area, was hunted from about 1712.

The successful introduction of the modern harpoon-gun, with a harpoon carrying an explosive charge, dates from 1865, and has revolutionised whaling, by making it possible to capture the large and swift rorquals or fin whales. Modern whaling is concerned mainly with the humpback whale, the fin whale, and the blue whale, all of which are widely distributed in nearly all seas, although it is not certain whether each of these whalers' names indicates the same species in all parts of the world. After rorquals had been hunted in such localities as the Varanger Fjord, Newfoundland, Iceland, the British and Norwegian coasts, and elsewhere, whaling on an unprecedented scale commenced off the edge of the Antarctic Continent in 1905, and is still being conducted energetically. The total catch in this area has exceeded 10,000 in a single year.

The principal whale-products of economic importance are: train-oil, sperm-oil, spermaceti, baleen, ambergris, whale meat, and the various forms of whale-meal or "guano." In a well-conducted factory all parts of the carcass are utilised.

With the exception of the Antarctic whaling, which has had a career of less than twenty years, whaling has been carried on consistently to an excessive amount, leading to the most serious reduction of the number of whales. The Atlantic and Greenland right whales were decimated almost to the point of extermination, the sperm whale industry has practically disappeared, and little remains now but the Antarctic whaling grounds. The efforts of all lovers of Nature should be directed to the restriction of whaling to an amount which is not inconsistent with the permanent preservation of these magnificent marine mammals and of the industry which they are so unfortunate as to support.

[1] Substance of a paper read before the Association of Economic Biologists by Sir Sidney F. Harmer, F.R.S., on November 10.

Biometric Studies.

IN the current issue of *Biometrika* (vol. xiv. pts. i. and ii.) Dr. Kirstine Smith discusses the standard deviation of a coefficient of correlation computed from data derived from classes, members of which are mutually correlated, with special reference to the case of fraternal and parental correlations calculated from entries of siblings. She finds, *inter alia*, that the best determination of a fraternal correlation from a given number of observations is obtained by taking $(1+1/r)$ offspring individuals from each family, where r is the fraternal correlation.

Mr. Egon S. Pearson contributes an important memoir on variations in personal equation. The experimental basis of the research was a series of five sets of measurements of different type; the form of sessional change, *i.e.* the resultant of factors operative within each series, is separated from the secular, or long period, change effective from one session to another; appropriate forms for the expression of each are discussed. It is evident that in the determination of the precise value of the correlation between successive judgments in a series, one has to reckon not only with physiological or psychological common factors, the organic basis of the correlation, but also with accidental errors which blur the record—the observational errors of some writers—and reduce the numerical value of the correlation. It is found that the correlations between successive judgments decrease approximately in geometrical progression with the number of intervals, a finding consistent with the assumption that there is little or no partial correlation between the observers' true estimates at intervals greater than one. The chief practical outcome of the work is to show that although "experience and accuracy may be gained by practice, it does not follow that the correlation between successive judgments will disappear."

The memoir is not only of practical interest to all experimenters, but also contains several contributions to statistical algebra. In connexion with the work on pp. 37 *et seq.*, a reference to the memoir of Anderson (*Biometrika*, x. 269) would have been in place, but no doubt Mr. Pearson will deal more fully with the literature of the subject in a sequel. He is to be congratulated on his first appearance in a field where one bearing his name must be judged by the highest possible standard.

Dr. Ernest Warren's paper concludes the account of work partly described in 1917 concerning inheritance in the foxglove. Dr. Warren holds that "the evidence of the present investigation is therefore definitely against any general application of the theory of pure lines and of genotypes of any appreciable magnitude, and further it indicates that selective breeding within self-fertilised generations of a homogeneous race is capable of modifying that race to a marked degree."

Prof. Karl Pearson and Mr. Egon Pearson show how to find a general polychoric coefficient of correlation, *i.e.* to fit the "best" normal surface to data subject to the limitation that the marginal totals are exactly reproduced. The arithmetical work is heavy, and the suggestion is that a determination of the correlation ratio from the array means—not a laborious task—will usually suffice.

Mr. James Henderson discusses the expansion of a function in tetrachoric functions, a matter of some importance to those who use the frequency systems favoured by Scandinavian mathematical statisticians.

It will be obvious that the fourteenth volume of *Biometrika* is as valuable to statisticians as its predecessors.

University and Educational Intelligence.

BELFAST.—The trustees of the late Mr. Henry Musgrave have just paid to the Queen's University the sum of 57,000*l*. Of this sum the income of 7000*l*. is to be applied towards paying an additional Reader in connexion with the chair of physics. The income of 20,000*l*. is to be applied in founding and maintaining studentships of not less than 150*l*. per annum for the encouragement of research in pathology, physiology, biology and chemistry. The disposal of the remaining 30,000*l*. is left to the discretion of the Senate.

CAMBRIDGE.—The Very Reverend W. R. Inge, Dean of St. Paul's, and Sir Sidney F. Harmer, Director of the Natural History Departments of the British Museum, have been elected honorary fellows of King's College.

K. P. Chatterji, Fitzwilliam Hall, has been elected to the Anthony Wilkin Studentship in ethnology and archæology.

The Raymond Horton-Smith prize has been awarded to Dr. A. B. Appleton, Downing College, for an essay on "Morphogenesis of Bone," and to Dr. H. W. K. Vines, Christ's College, for an essay on "Certain Physiological Functions of Calcium Salts."

The Gordon Wigan prize in chemistry has been awarded to R. G. W. Norrish, Emmanuel College, for an investigation on "The Photochemistry of Potassium Permanganate."

It is proposed to appoint a University lecturer in embryology.

OXFORD.—An important collection of early scientific instruments has been offered as a gift to the University by Mr. Lewis Evans, a condition attached to the gift being that a suitable place should be provided for showing it, this to be approved by Mr. Evans. The collection is at present exhibited in the Picture Gallery of the Bodleian Library, where it will be allowed to remain until the end of the summer of 1924. In the meantime it will be necessary to fix on a permanent lodging for the collection, and a proposal by Mr. R. T. Gunther, Fellow of Magdalen College, to allot for this purpose the upper rooms of the historic Ashmolean Museum has the support of the heads of all the scientific departments concerned, of the Board of the Faculty of Natural Science, and of many other resident members of the University. As stated in NATURE of December 9, p. 783, the collection is especially rich in instruments for the determination of time. There is a series of astrolabes, sixty-three in number. There is also a large array of dials, both stationary and portable; the former includes Wolsey's sundial, which was probably designed by Nicolas Kratzer, the first Oxford professor of astronomy; while among the latter can be seen a fine Elizabethan finger ring dial, and a Roman portable dial of the second or third century A.D., stated to be the only perfect example known of this particular type of timepiece.

DR. KATIE BARRATT, lecturer in the department of biology at the Imperial College of Science, South Kensington, has been appointed principal of the Horticultural College, Swanley, Kent.

THE British Association Committee on Training in Citizenship has produced three valuable reports, each of which is available separately for a few pence, and at reduced prices if purchased in dozens or hundreds. The first report, presented at the Cardiff meeting in 1920, contains a syllabus of a course in civics and notes on regional surveys; the second, presented at Edinburgh in 1921, surveys the position of the subject and summarises views of leading teachers upon its scope and purpose; and the third, presented at the Hull meeting in September last, contains a full bibliography of civics. Prices and other particulars may be obtained from the honorary secretary of the committee, Lady Shaw, 10 Moreton Gardens, London, S.W.5.

WE have received from the University of Hong-Kong a pamphlet describing its aims and needs, with special reference to an offer by the Rockefeller Foundation of New York of an endowment of half a million dollars for chairs of medicine and surgery, conditional only upon the Faculty being brought into harmony in other respects with modern standards of efficiency. This will cost at least 400,000 dollars. The university holds a position unique among British universities in that its policies are to a large extent dominated by its nearness to and relations with a foreign country. Its charter of incorporation declares that its objects include ". . . the development and formation of the character of students of all races, nationalities, and creeds, and the maintenance of good understanding with the neighbouring country of China," and its general aim has been defined as "the provision of facilities and especially of the atmosphere of a residential British university with such modifications . . . as the national and intellectual outlook of the Chinese student may call for." One of its chief merits in the eyes of Chinese parents is that its students get the benefit of a British university education without becoming denationalised. It was opened only two years before the outbreak of the Great War and until 1920–21 its progress was slow. During the past two years, however, the number of students has rapidly increased, and there are now about 250, nearly all of whom reside in university or recognised (mission) hostels. Of students who have graduated from the several faculties (medicine, engineering, and arts) the greatest number—77—took degrees in engineering.

PROF. L. NATANSON sends us the following information summarising the growth and progress of university education in Poland. In the last completed year (1921–22) Poland had five State-endowed universities (Cracow, Warsaw, Lwów, Poznan, Wilno), two high technical schools (Warsaw, Lwów), two "free" or private universities (Lublin, Warsaw), and seven other special colleges of university rank. In these institutions, 1926 persons were engaged in teaching during the session under review, namely: 833 full or "ordinary" professors, 176 assistant or "extraordinary" professors, and 917 lecturers and provisionally appointed teachers. The total number of students enrolled for the same period was 34,708, of whom 8015 were women. The University of Warsaw had the largest number of students in attendance, namely, 7518; the Technical High School of Warsaw had 4112 students. Polish universities contain faculties of theology, jurisprudence, medicine, physical and natural science, philosophy, history and philology; in addition to these, sub-faculties or special departments exist in several universities, devoted to agriculture, pharmacy, veterinary science, and so on. As to the specialty of their study, the students may be divided as follows: theology 1 per cent., jurisprudence 29·1, medical science 13·2, pharmacy 0·9, veterinary science 1·1, stomatology 1·5, philosophy, philology, history and pedagogical science 26·4, agriculture 5·9, commercial science 2·1, chemistry 2·8, mining 0·8, other technical studies 14·4 per cent. The following information is also available relating to the mother-tongue of students in the University of Warsaw: Polish language 89·0 per cent., Russian 2·0, German 0·25, Hebrew 4·25, Jewish 3·25, other languages 1·25 per cent. About 74 per cent. of the number of students were trained in secondary schools chiefly of classical and literary type; the rest, about 26 per cent., had received preparation in schools in which experimental and practical science was the basis of instruction.

Calendar of Industrial Pioneers.

December 18, 1888. Joseph James Coleman died.—One of the pioneers of the cold storage industry, Coleman was first a teacher of chemistry and then chemical engineer to Young's Paraffin Works, Bathgate, Glasgow, where he devised means of liquifying gases, and with Bell introduced the Bell-Coleman dry-air refrigerating system which revolutionised the meat-carrying trade.

December 19, 1877. Heinrich Daniel Ruhmkorff died.—Ruhmkorff was born in Hanover in 1803 and in 1819 went to Paris as assistant in a laboratory. There he started in business for himself and became a successful electrical instrument maker. In 1844 he invented a thermo-electric battery, and in 1851 brought out the Ruhmkorff coil for which he afterwards received a prize of 50,000 francs at the French Exhibition of Electrical Apparatus.

December 20, 1904. Sir Isaac Lowthian Bell died.—The son of an engineer of Newcastle, Bell studied at Edinburgh and at the Sorbonne, and in 1854, with his brothers, founded the Clarence Iron Works on the Tees, the firm ultimately employing some 6000 men. Bell was distinguished as an investigator and writer on metallurgy, and as a man of affairs assisted to found the Iron and Steel Institute, of which he served as president in 1873–75. He was also the first recipient of the Bessemer Gold Medal.

December 21, 1909. Charles B. Dudley died.—From 1875 to 1909 Dudley was chemist to the Pennsylvania Railroad Company, in which situation he carried out a number of important researches on the properties of materials and other matters connected with railways. He was president of the American Chemical Society, and at the time of his death, president of the International Association for Testing Materials.

December 22, 1867. Jean Victor Poncelet died.—A distinguished French engineer and mathematician, Poncelet passed through the École Polytechnique, served in the army, was taken prisoner on the retreat from Moscow, and during his confinement began writing his "Traité des propriétés projectives des figures." He rose to high military rank, held a chair of mechanical physics in Paris, published a treatise on practical mechanics, improved the water wheel, and invented a turbine.

December 23, 1895. Sir Edward James Harland died.—The founder of the great shipbuilding firm of Harland and Wolff, of Belfast, Harland was born in 1831 at Scarborough, served an apprenticeship under Robert Stephenson at Newcastle, and became draughtsman to J. and J. Thomson, Glasgow. In 1854 he removed to Ireland, becoming the owner of a small shipbuilding concern, in which he was joined by Wolff in 1860. Among the most notable vessels he constructed was the Atlantic liner *Teutonic*, which, built in 1889, was the first mercantile vessel to be fully armed and equipped as an auxiliary cruiser. She was 560 feet long, displaced 16,740 tons, and with 17,500 horsepower attained a speed of twenty knots.

December 23, 1865. Alan Stevenson died.—The eldest son of Robert Stevenson (1772–1850), whom he succeeded as engineer to the Scottish Lighthouse Commissioners, Stevenson erected ten lighthouses, among them being that at Skerryvore, "the finest example for mass combined with elegance of outline of any extant rock tower." This lighthouse, which was built between 1838 and 1843, is 138 feet high and weighs 4300 tons.

E. C. S.

Societies and Academies.

LONDON.

Royal Microscopical Society, November 15.—Prof. F. J. Cheshire, president, in the chair.—**C. Singer**: The earliest drawings made by means of the microscope. These drawings, probably the earliest made, were prepared in 1625, 3 years before the birth of Malpighi and 8 years before the birth of Leeuwenhoek. They represent the anatomy of a bee, of which the mouth parts are particularly accurately rendered. The drawings are to be found on the fly-leaf of an excessively rare book, the "Melissographia" of Federigo Cesi, Duke of Aquasparta. The only specimen of this book known to exist is in the Lanuvian library at Rome. The drawings were made under the supervision of Cesi himself and of his colleague in the first "Academy of the Lynx," Francesco Stelluti. A mechanical microtome was constructed by the instrument maker Cummings in 1770 and described by the notorious Sir John Hill.

Physical Society, November 24.—Dr. Alexander Russell, president, in the chair.—**E. G. Richardson**: The theory of the singing flame. Lord Rayleigh's theory of the action of the singing flame fits the results most closely, in that (1) heat is given by the flame to the air in the tube at each condensation, and (2) stationary waves are formed in the gas as well as in the air-tube. But the lengths of gas-tube unfavourable to the "singing" cover a more restricted range than Lord Rayleigh surmised.—Miss **Alice Everett**: Unit surfaces of Cooke and Tessar photographic lenses. A number of rays in an axial plane (and a few general rays) are traced through the lens systems by exact methods, and on each ray the positions of the conjugate points for unit magnification are found by Mr. T. Smith's formulæ. For general rays the loci of these "unit points" are three-dimensional. They are surfaces only when the chief rays are bound by some condition such as passing through a fixed point of the object. Within the region for which the lenses are designed, the curvature of both object and image unit-point loci is positive (convex to the light source) and the image locus is more curved than the object locus.—**R. Ll. Jones**: Vibration galvanometers with asymmetric moving systems. The theory of vibrations of a system with two degrees of freedom is given, expressions for the amplitudes of the forced vibrations are deduced, and the conditions for resonance ascertained. The results are applied to a galvanometer in which the moving system is asymmetrically hung on a laterally yielding axis, and it is found that the formula for the amplitude is capable of reproducing with fair accuracy the sensitivity curve of the galvanometer, which shows multiple resonance. Asymmetry always lowers the sensitivity of the resonance.—Paul **Schilowsky**: Some applications of the gyroscope. To stabilise a system in unstable equilibrium a reaction must be set up between the system and the gyrostat of such a character as to *help* the precession of the gyrostat during the return of the system to normal. To check the oscillations of a stable system, the reaction must be such as to *oppose* such precession. The gyrostat must be power-driven to neutralise friction. A collection of apparatus for teaching purposes, comprising, *inter alia*, models illustrating the precession of the earth, a method of optically projecting an image of a spinning top, and small mono-rail models, was exhibited. To prevent rocking in a model ship a

gyrostatic fly-wheel is mounted with its axle vertical in a frame, which can both rock about and slide along an axis transverse to the ship. In an aeroplane the problem of combining automatic stability with mobility while avoiding dangerous stresses was discussed. Angular velocity of the aeroplane about a vertical axis causes a tendency to precess in a gyroscope rotating about an horizontal axis. This is balanced by a gravity control, and the angle moved through in attaining a balance affords a measure of the required angular velocity. In models of mono-rail gyrostatic apparatus the fly-wheel is mounted with its axle vertical in a frame which can tilt in a fore-and-aft plane and also slide sideways under gravity. The frame is mounted by a pinion co-axial with and geared down from the fly-wheel; the pinion lies between, but normally clear of, two parallel fixed racks mounted on the carriage, and having their lengths in a fore-and-aft direction. In practice the gyrostatic apparatus would form from 3 per cent. to 5 per cent. of the load of a ship, and from 5 per cent. to 10 per cent. of the load of a mono-rail carriage.—**P. Ditisheim**: A new balance for compensating the temperature error of watches and chronometers. Elinvar, an alloy invented by Dr. Ch. Ed. Guillaume, the elasticity of which is not affected by changes of temperature, is used for the hair-spring. Satisfactory timing can thus be obtained up to certain limits with a plain solid uncut balance. To apply the elinvar spring to higher-grade watches a new compensation balance has been designed. It is made from a plain monometallic uncut ring into which two very small symmetrical bimetallic blades are inserted. The latter will enable small corrections to be made in order to obtain very fine rates.

Aristotelian Society, November 27.—Prof. A. N. Whitehead, president, in the chair.—**R. F. A. Hoernlé**: Notes on the treatment of "Existence" in recent philosophical literature. The ontological argument is treated in current philosophical literature (*a*) in a *restricted* form, in which it applies only to the unique case of God, and (*b*) in a *generalised* form, in which it is one with the problem of the validity (or "reference to reality") of thought in general. Prof. A. E. Taylor's criticisms of the restricted argument, in his article on "Theism" in the "Encyclopedia of Religion and Ethics," are mutually contradictory, but they contain the valuable suggestion that the validity of the argument depends on the meaning of the term "God," or of the terms defining "God." What these terms *mean* can be decided only by asking what they *express*, and this requires that we should not divorce the language of the argument from the religious experience (=Anselm's *fides*) which underlies it. Thus, the restricted argument appears as but a special case of the generalised argument which depends on the principle that experience, as the union of "that" and "what," "existence" and "essence," supplies the missing existential premise for all meanings which are well-founded. The generalised argument depends on maintaining consistently the "epistemic" against the "formal-logic" point of view. In formal logic, no definition, as such, can imply the existence of the thing defined; no class-concept can imply that the class has members. But, if instead of beginning with definitions, concepts, suppositions (*Annahmen*), we take the *epistemic* point of view and ask what the terms of the definition, etc., mean, *i.e.* what they express, or what we are asked to think *with*, we are driven back to concrete experience in which meanings are *realised*, and in which, therefore, essence is not divorced from, but is one with, existence.

Linnean Society, November 30.—Dr. A. Smith Woodward, president, in the chair.—**R. J. Tillyard**: The wing-venation of the order Plectoptera or May-flies.—**D. S. M. Watson** and **E. L. Gill**: The structure of certain palæozoic Dipnoi (fishes).—**J. Duncan Peirce**: The Giant Trees of Victoria. The tallest trees grow in gullies between ridges, the greater moisture and abundance of leaf-mould conducing to their height; the highest tree measured was 326 ft. 1 in.

CAMBRIDGE.

Philosophical Society, November 13.—Mr. C. T. Heycock, president, in the chair.—**A. Smith Woodward**: The skulls of palæolithic men.—**W. M. H. Greaves**: On a system of differential equations which appear in the theory of Saturn's rings.—**C. G. Darwin** and **R. H. Fowler**: Fluctuations in an assembly in statistical equilibrium.

SHEFFIELD.

Society of Glass Technology, November 22.—**W. E. S. Turner**: The glass industry and methods of manufacture in Czecho-Slovakia. The technical side of the glass industry has not in recent years made anything like the progress that it has in this country. The Bohemian glass industry is living largely on its old tradition and the existing store of knowledge. Machinery scarcely exists for the manufacture of glassware. A great deal of money was made in the industry in the boom years of 1919 and 1920, but very little was put into the industry to improve it. In many methods, from a technical point of view, Great Britain leads the Continent at the present time.—**A. Cousen**: Selenium in the production of colourless glass. A large number of experimental melts were made to determine the effect of various batch materials on the decolourising power of selenium and the effect of the duration of melting on the colour developed.

DUBLIN.

Royal Dublin Society, November 28.—Mr. G. Fletcher in the chair.—**J. Wilson**: On the variation of milk-yield with the cow's age and the length of the lactation period. Ten years ago, working on data, from the cows exhibited at the London Dairy Shows, it was found that, if cows' yields at eight years old be set down as 100, the yields at earlier ages work out at about 67 for 3-year-olds; 81 for 4-year-olds; 90 for 5-year-olds; 95 for 6-year-olds; and 98 for 7-year-olds. Recently Dr. Raymond Pearl of Washington and Dr. Tocher of Aberdeen, working with data collected by the Ayrshire Cattle Milk Records Committee, have found yields for the younger ages to be considerably higher, but the Ayrshire records cannot be used to find how yield increases with age, because the breed has been out of equilibrium since about twenty years ago; the records are loaded in favour of those of the younger ages. If twelve months from calf to calf be taken as the normal lactation period, the annual yield is reduced by about 20 gallons in an eleven months lactation, and increased by about 35, 65, and 90 gallons in thirteen, fourteen, and fifteen months lactation periods.—**H. H. Poole**: On the detonating action of α-particles. Experiments show that the probability of detonation of a specimen of iodide of nitrogen by α-particles is proportional to the concentration of the particles, and not to the square, or a higher power, of the concentration. Hence, detonation is caused by a single α-particle, and not by the joint effect of two or more particles, and it is reasonable to assume that detonation is caused by the collision of the particle with a nitrogen or a hydrogen nucleus. Fulminate of mercury, silver

azide, and several other explosives were not detonated by exposures to α-particles which would have caused several thousand detonations of iodide of nitrogen. Probably only a very sensitive body, such as the iodide, can be detonated in this way, and the risk of such an effect with detonators or explosives in common use is negligible.—T. G. **Mason**: Note on the growth and the transport of organic substances in bitter cassava (*Manihot utilissima*). Weekly measurements of 20 plants were made over a period of 27 weeks; alternate plants were ringed close to the ground. The rate of growth of the stems of the ringed plants was not affected by the operation for about 3 weeks; it then commenced to lag behind that of the unringed plants. The weight of the tuberous roots formed by the ringed plants was about one quarter of that formed by the unringed; the weight of the stem was more than 1·2 times as much. Probably the activity of the cells of the apical meristem is not controlled by the available supply of organic substances, but is determined by autogenous changes within the growing point. No evidence was obtained of the presence of a factor correlating the activity of the apical meristem and the growth of the tuberous roots. The results are in accord with the view that the rate of growth of the stem is conditioned by the catalytic activity of the cells of the apical meristem.

PARIS.

Academy of Sciences, November 20.—M. Emile Bertin in the chair.—The president announced the death of M. G. Lemoine.—Marcel **Brillouin**: Einstein and Newtonian gravitation. Remarks on a recent note by M. Le Roux. The criticisms of M. Le Roux are regarded as unfounded.—Pierre **Termier**: The structure of the eastern Alps.—L. **Joubin**: The geographical distribution of some deep-sea corals in western European seas. In consequence of the increase in the size and power of steam trawlers, trawling is now carried out at much greater depths than formerly. As a result, the quantities of coral brought up in the nets causes great inconvenience. As a guide to fishermen, a chart is given showing the distribution of the most objectionable corals (Lophohelia, Amphihelia, Dendrophyllia), so that the trawlers can avoid these localities.—E. **Mathias**, C. A. **Crommelin**, and H. **Kamerlingh Onnes**: The rectilinear diameter of neon. The purification of the neon used in these experiments is described in detail, and its purity was confirmed of observations of the critical phenomena. Neon obeys the law of the rectilinear diameter. Like other gases, the diameter shows a deviation in the neighbourhood of the critical point. In the case of hydrogen the deviations are distributed irregularly, but with neon they are systematic: at low temperatures the diameter is slightly convex to the temperature axis, and at higher temperatures slightly concave. Argon, nitrogen, and carbon dioxide behave similarly.—M. Charles **Camichel** was elected Correspondant for the section of mechanics.—S. **Bays**: Steiner's cyclic systems of triplets.—A. **Myller**: Remarkable ruled surfaces passing through a given curve.—Paul **Mentré**: Complexes which present projective singularities of the second infinitesimal order.—H. **Roussilhe**: Results obtained in 1921 and 1922 by the application of aerial photography to precision plans on the large scale. The mean errors of plans derived from aerial photographs are less than those of a topographical plan taken with every precaution; the area covered by a given staff is also greater when the photographic method is employed.—C. **Raveau**: Fresnel's law of the entanglement of the æther.—Emmanuel **Dubois**: The minimum potential of electric discharge in gases at low pressures. Some anomalies described in an earlier communication have been now shown to be due to the presence of saline substances on the electrodes.—L. **Bouchet**: An absolute plane-cylinder electrometer. A cylinder is mounted on a balance beam and the attraction between the cylinder and a plane surface measured. The theory of the instrument is developed. The limits between which the formula holds have been determined by experiment.—Georges **Déjardin**: The production of the spectrum of mercury. The influence of helium. A study of the spectrum emitted by mercury vapour traversed by electrons of variable velocity. The lines are those of the arc spectrum. For potentials below 20·4 volts a mixture of helium and mercury vapour gives the same arc spectrum as that observed in the absence of helium. Above 20·4 volts the mercury spectrum undergoes modification, and at the same time the helium spectrum appears.—Pierre **Lafon**: Anomalies in the expansion of glass.—A. **Portevin**: The reduction and disappearance of internal strains in steels by reheating followed by slow cooling.—André **Kling** and D. **Florentin**: The spontaneous formation of sulphate on limestone in urban centres. Chemical analyses of various limestone structures, showing the serious attack by the sulphuric acid in town atmospheres.—MM. **Tiffeneau** and **Orékhoff**: The semipinacolic transposition of the alkylhydrobenzoins: the influence of the alkylradicles.—Raymond **Delaby**: The alkylglycerols. The preparation of vinylalkylcarbinols.—E. **Grandmougin**: The acyl-aminoanthraquinones as vat dyes.—Paul **Gaubert**: The action of heat on spherolites.—H. **Joly**: Preliminary note on the general direction and age of the folds of the Celtiberic Chain (Spain).—M. **Teilhard**: A fauna of mammals found in northern China.—V. **Van Straelen**: The decapod crustaceans of the Callovian of Voulte-sur-Rhône (Ardèche).—Lucien **Daniel**: Hyperbioses of the sunflower and artichoke.—Maurice **Lenoir**: The nucleoles during the prophase of kinesis II. of the embryonic sac of *Fritillaria imperialis*.—M. **Mascré**: The stamen of the Boraginaceæ.—Mlle. Marie **Braecke**: The presence of aucubine and of melampyrite (dulcite) in several species of Melampyrum. Aucubine was isolated from *Melampyrum pratense*, *M. nemorosum*, and *M. cristatum*: dulcite (Hünefield's melampyrite) was also extracted in the pure state from the two latter species.—Pierre **Lesage**: The comparative action of sylvinite and its components on the first development of plants. Sylvinite proved more favourable to the development of seedlings than its constituents (chlorides of sodium, potassium, magnesium, and calcium sulphate) taken separately, or even when mixed in the proportions present in the mineral employed.—J. **Stoklasa**: The respiration of the roots. Experiments are described confirming the conclusion published by the author in an earlier communication, that no acid, organic or inorganic, other than carbonic acid is secreted by growing roots. The respiration of the roots is more intense in the presence of air containing radium emanation.—A. **Goris** and P. **Costy**: Urease and urea in fungi.—L. **Léger** and A. Ch. **Hollande**: Coccidia of the intestine of the eel.—L. M. **Betances**: Some refinements on the morphogenesis of the hæmatic cell.

CAPE TOWN.

Royal Society of South Africa, September 27.—Dr. J. D. F. Gilchrist, president, in the chair.—H. B. **Fantham**: Some Protozoa found in soils in South Africa. Protozoa belonging to the Sarcodina, Mastigophora, and Ciliata have been found. As regards actual numbers of organisms, flagellates are the

most numerous. There is daily variation in the numbers of a Protozoon in a given quantity of culture. Dark, heavy soils containing much humus yielded more kinds of Protozoa than sandy ones. Samples of soil taken relatively near the surface, say six or eight inches down, usually yielded more Protozoa than deeper samples. Cultivated soils yielded more species of Protozoa, especially of Ciliata, than uncultivated ones. Owing to partial sterilisation of South African soils by solar heat and drought, the number of Protozoa in a given area of soil seems to be less than in soils from England or the northern United States. The ingestion of bacteria by soil Protozoa has, so far, not been often observed naturally in South African soils.—J. A. **Gilmore**: Note on elasticity of Dwyka Tillite. Investigation of Dwyka Tillite from Matjesfontein, Cape Province, shows that for an absorption of water of less than 1/400 gm. per gm., Young's Modulus decreases by about 12 per cent., whereas for an absorption of order 1/800 gm. per gm. the crushing strength increases by about 50 per cent. or more.—H. O. **Mönnig**: On some new South African parasitic nematodes.—Sir Thomas **Muir**: Note on the co-evanescence of the primary minors of an axisymmetric determinant.—T. J. **Mackie**: The serum constituents responsible for the Sachs-Georgi and the Wassermann reactions. Sera were fractioned by Liefman's carbon-dioxide method; the carbonic-acid-insoluble globulin was inactive and inhibitory in the flocculation test. The carbonic-acid-soluble fraction was further fractioned into pseudo-globulin and albumin components and flocculation was found to be due almost entirely to the former. In the Wassermann reaction, the most active fraction is the carbonic-acid-insoluble globulin.—J. R. **Sutton**: Note on the propagation of heat in water. Harmonic analysis of hourly observations of the temperature of water in a brick cistern, 7 feet square and 30 in. deep, shows that the whole body of water is heated nearly simultaneously (chiefly by the sun's rays) and that the surface temperature is propagated downward as a wave of about 7 in. per hour.

Royal Society of South Africa, October 18.—Dr. J. D. F. Gilchrist, president, in the chair.—Miss A. V. **Duthie**: The cones, spores, and gametophytes of *Selaginella pumila*.—F. G. **Cawston**: South African larval trematodes and the intermediary hosts. The commoner species of fresh-water mollusc found in certain rivers of South Africa, as well as some lagoon inhabitants which are occasionally found in quite fresh water, together with the commoner larval trematodes of these localities, are described.—J. **Moir**: Colour and chemical constitution, Pt. XVIII.: Colourless substances in concentrated sulphuric acid solution (halochromy). Observations on coloured solutions in sulphuric acid of 25 simple substances, mostly colourless *per se*, are recorded, and a scheme for calculating colour from chemical constitution is put forward.—J. **Stuart Thomson**: African Alcyonaria with a statement of some of the problems of their dispersal.

Official Publications Received.

Straits Settlements. Annual Report on the Raffles Museum and Library for the Year 1921. By Major J. C. Moulton. Pp. 16. (Singapore.)

The Royal Technical College, Glasgow. Annual Report on the One Hundred and Twenty-sixth Session adopted at the Annual Meeting of Governors, held on the 17th October 1922. Pp. 71. (Glasgow.)

County Borough of Warrington: Museum Committee. Report of the Keeper of the Museum for the Two Years ending 30th June 1922, with a List of the Principal Additions to the Museum Collections. Pp. 18. (Warrington.)

Department of the Interior: Bureau of Education. Bulletin, 1922, No. 20: State Laws relating to Education enacted in 1920 and 1921. Compiled by Wm. R. Hood. Pp. iv+269. (Washington: Government Printing Office.) 25 cents.

Department of Fisheries, Bengal. Bulletin No. 19: Statistics of Fish imported into Calcutta for the Year ending 31st March 1922. Pp. 14. (Calcutta: Bengal Secretariat Book Depot.) 8 annas.

Diary of Societies.

SATURDAY, DECEMBER 16.

BRITISH ECOLOGICAL SOCIETY (Annual Meeting) (at University College), at 10.30 A.M.—Dr. R. Lloyd Praeger: Dispersal and Distribution (Presidential Address).—Dr. Cockayne's Work on the Tussock Grassland of New Zealand (Lantern and Specimens).—J. Ramsbottom: The Mycology of the Soil.—W. H. Pearsall: Plant Distribution and Basic Ratios.

BRITISH PSYCHOLOGICAL SOCIETY (Annual General Meeting) (at University College), at 3.—S. J. F. Philpott: The Analysis of the Work Curve.—H. Gordon: Hand and Ear Tests.

MONDAY, DECEMBER 18.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge, Kensington Gore), at 5.—Col. Sir Gerald Lenox-Conyngham: The Proposed Determination of Primary Longitudes by International Co-operation.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—E. E. Sharp and others: Discussion of Time Switches.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section), at 7.—A. J. Gould: Warships.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—A. N. C. Shelley: The Law of Building outside London.

ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street), at 8.—Prof. R. W. Sellars: Body and Mind.

CHEMICAL INDUSTRY CLUB (at 2 Whitehall Court), at 8.—Dr. W. R. Ormandy: Paper.

TUESDAY, DECEMBER 19.

ROYAL SOCIETY OF MEDICINE, at 5.—General Meeting.

ROYAL STATISTICAL SOCIETY, at 5.15.—T. T. S. de Jastrzebski: Changes in the Birth Rate and in Legitimate Fertility in London Boroughs, 1911–1921.

INSTITUTION OF CIVIL ENGINEERS, at 6.—F. M. G. Du-Plat-Taylor: Extensions at Tilbury Docks, 1912–1917.

INSTITUTE OF MARINE ENGINEERS, INC., at 6.30.—Film illustrating Industrial Works—Messrs. Hadfields.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Technical Meeting), at 7.—H. T. G. Meredith: Gravure.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Dr. C. Fox: The Distribution of Population in the Cambridge Region in Early Times, with special reference to the Bronze Age.

WEDNESDAY, DECEMBER 20.

ROYAL SOCIETY OF MEDICINE (History of Medicine Section), at 5.—Dr. Nixon: The Debt of Medicine to the Fine Arts.

ROYAL METEOROLOGICAL SOCIETY, at 5.—C. J. P. Cave and R. A. Watson Watt: The Study of Radiotelegraphic Atmospherics in Relation to Meteorology.—C. J. P. Cave: Winter Thunderstorms in the British Islands.—D. E. Row: Forecasting Sky Types.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—W. A. Richardson: A Micrometric Study of the St. Austell Granite (Cornwall).—W. G. Shannon: The Petrography and Correlation of the Igneous Rocks of the Torquay Promontory.—Prof. O. T. Jones: Demonstration of the Crystallisation of a Doubly-Refracting Liquid.

ROYAL MICROSCOPICAL SOCIETY, at 8.—J. E. Barnard: Sub-Bacteria.

THURSDAY, DECEMBER 21.

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 5.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—F. White: Notes on the Correction required to Aneroid Readings for Altitude to counteract the Effect produced by the Diurnal Barometric Wave.—P. C. Whitehead: Some Notes on the Secondary Sulphide Enrichment exhibited by certain Auriferous Veins.

CHEMICAL SOCIETY, at 8.

PUBLIC LECTURES.

SATURDAY, DECEMBER 16.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. N. Milligan: Animals without Teeth.

THURSDAY, DECEMBER 21.

CITY OF LONDON Y.M.C.A. (186 Aldersgate Street), at 6.—Sir John N. Jordan: Some Chinese Problems.

SATURDAY, DECEMBER 23, 1922.

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The British Scientific Glass Industry.

THE review of the development of the British glass industry, given by Prof. W. E. S. Turner recently in his presidential address to the Society of Glass Technology, throws new light on an industry which some have been inclined to think had to be largely created in this country after the outbreak of war. It appears that, even during the early days of its development in the seventeenth century, the industry made three notable contributions to manufacturing technique, namely, the use of coal instead of wood as a fuel, the introduction of covered melting-pots, and the preparation of lead crystal glass, which, in the course of time, ousted the famous Venetian glass from favour. Moreover, right through the nineteenth century, until about 1875, Great Britain held an important place amongst the glass-making countries of Europe, after which date its exports declined, due in a considerable measure to foreign tariff duties.

Prof. Turner shows something of the great revival of enterprise during the war period and afterwards, and of the extensiveness with which glass manufacturers have been installing new plant and machinery. In these phases of activity, no country in Europe can show a comparable record, and we may be permitted to indulge the hope that a brighter period lies before the industry than it experienced between 1875 and 1915.

In these columns we are interested mainly in the subject of scientific glass, and we have been forced to ask at times if the real position in regard to this branch has been understood or appreciated. Most divergent opinions on the merits of British scientific glass have been expressed. On one hand, very severe criticisms have been made of the quality of British scientific glass. On the other, we may say that we have seen letters, written spontaneously, testifying in glowing terms to its merits as compared with Continental glass; and inquiries in large laboratories have shown similar divergence of opinion, the balance of evidence being favourable. Possibly, users of scientific glassware have grown more critical of late years; they have been forced to this position partly by the prominence of the subject and partly by the financial stringency existing in scientific institutions. Moreover, the relations between the manufacturers and the dealers in this country appear not to have been of the most cordial character, and this fact cannot be ignored in estimating the chances of British ware in its claim to recognition.

It is interesting to contrast the beginnings of the chemical and scientific glass industry in the United Kingdom with the early operations at Jena. In our

own country both glass compositions and processes had to be extemporised in a great hurry, and it is indeed creditable to workers like Sir Herbert Jackson outside the factory, and Dr. M. W. Travers, Dr. C. J. Peddle, and Mr. John Kaye inside the factories, that glass vessels at least as durable chemically as any produced in Germany were forthcoming in so short a time. The earlier samples, just like those from Jena, when chemical ware was first made there in 1893, were far from being mechanically perfect. Processes and methods for the graduation of instruments had likewise to be worked out, and it has to be borne in mind that such work was in some instances taken up by persons who were more enthusiastic than competent. Many British people find it difficult to forget these early defects and have been ever ready to sigh for the return of German goods.

The work at Jena, which began about 1881, had ample time to be carried out systematically. The success of the work was due not altogether to the application of new elements to glassmaking but rather to the facilities for a great number of experimental meltings, some of them on a considerable scale, in which the influence of oxides, such as boric, zinc, barium, magnesium, and phosphoric, could be more fully investigated than had been the case by earlier workers. In this way there was gradually built up a series of definite relationships between chemical composition and physical properties, on the basis of which not only were new optical glasses devised but a new type of glass for laboratory use finally developed. Abbe himself was so impressed with the need of financial assistance in these undertakings and with the time consumed in carrying them out as to write: "The difficulties connected with such undertakings are so great, the initial outlay required is so heavy, and success if attained lies so far in the future, that there is little inducement to enterprise. A revolution of the industry can scarcely be brought about in any other way than by the means for its advancement being provided in liberal measure, either by corporations or public authorities."

Both scientific workers and manufacturers in the United Kingdom have well realised the truth of Abbe's remarks, and the user of scientific glass should also understand it. Since the war, despite the severe disappointment of the manufacturer in this country at the support given him, research has gone on continuously. A new type of chemical glassware has appeared on the British market, marking a departure in some ways from previous types and compositions, and as the results of extensive researches now in operation in this country become more and more complete, it is highly probable that still further types will be developed.

It is very likely that the Jena workers in later years acquired much systematic information that was never published. We have done very much here recently to revise the data which they have published and to show in some ways that it was defective and incomplete; while many other lines of research in this country, with the fundamental researches carried out in America, have given us resources of information which the German workers did not possess.

The very fact that, since the war, four new institutions, namely, the Department of Glass Technology at Sheffield, the Society of Glass Technology, the British Scientific Instrument Manufacturers' Research Association, and the Glass Research Association, have not only come into existence, but have also continued in full operation, affords convincing evidence that our manufacturers of scientific glassware are not content with their present attempts but are reaching out for something better. In this endeavour they are worthy of all the help and support, as well as patience, which the body of scientific workers can give them.

Our Nearest Living Relatives.

The Origin and Evolution of the Human Dentition. By Prof. William K. Gregory. Pp. xviii + 548 + 15 plates. (Baltimore, Md.: Williams and Wilkins Co., 1922.) n.p.

IT has so happened that Dr. W. K. Gregory, of the American Museum of Natural History, New York, and the writer of this review have each set out, at an early point in their lives, to seek for a definite answer to the same question: what is Man's lineage? Is he but a branch of the stem which gave the world its great living anthropoid apes—the gorilla, chimpanzee, and orang—or must we carry our lineage into a remote geological past to find the point of its separate emergence from the primate phylum? The reviewer approached the problem by making an elaborate analysis of the structural "make-up" of man and of anthropoid apes, noting the kind and extent of their common heritage and the kind and extent of the structural features peculiar to each, which therefore may be regarded as latter-day acquisitions.

Dr. Gregory has sought an answer by following a totally different route. He has approached it by following the geological record; he has an unrivalled knowledge of the fossil remains of early forms of primates found so abundantly in the Eocene deposits of North America; and as teeth and jaws, or fragments of them, are the most persistent parts of the mammalian skeleton, it has come about that the geological history of the various orders of mammals has to be based on an interpretation of dental hieroglyphics. In deciphering

the ancient alphabet of the teeth, particularly as regards the teeth of primate forms, Dr. Gregory is our most highly trained expert. The survey he has now issued embraces not only the American tarsioid and lemuroid fossil forms, lying in or near the basal phylum which has given us our modern apes and lemurs, but also includes an examination of the corresponding fossil forms found in Europe. He deals minutely with the fossil remains of apes found in the Oligocene deposits of Egypt, the anthropoid remains found in the Miocene and Pliocene deposits of Europe and of India—particularly those described in 1915 by Dr. G. E. Pilgrim, of the Indian Geological Survey,—and the various discoveries which have been made of fossil human remains.

Although the routes chosen by Dr. Gregory and by the reviewer have been different they have led to exactly the same goal—namely, that the gorilla, chimpanzee, and man are twigs growing from the same branch of the great primate stem. "Taken as a whole," writes Dr. Gregory, "the testimony of comparative anatomy affords cumulative evidence for Darwin's inference *that some ancient member of the anthropomorphous sub-group gave birth to man*. The detailed studies of the dentition in Part IV. of this work leads me to the conclusion that *the ancient member of the anthropomorphous sub-group* was closely allied to, or even identical with Sivapithecus or Dryopithecus of the Miocene Simiinae."

The reviewer agrees with Dr. Gregory that, on comparing the structural "make-up" of man with that of the great anthropoid apes, "the resemblances are far more numerous, detailed, and fundamental than the differences"; the reviewer would go further and say that in any theory of human lineage the common origin of man, the gorilla, chimpanzee, and orang, must be regarded as a "fixed point" in framing all our speculations. At this early stage in our search for man's pedigree, with only fragmentary documents at our disposal, and with yawning gaps in our book of evidence, complete unanimity between any two investigators cannot be expected.

In Dr. Gregory's opinion mankind is, in a geological sense, a recent product. So late as mid-Miocene times—about a million of years ago if we accept Dr. Gregory's rough estimate—he believes that our ancestry was represented by such fossil forms as Sivapithecus or Dryopithecus—which, so far as we yet know them, must be regarded as true anthropoid apes, not very different from the chimpanzee and gorilla. There is no ground for supposing that in foot or in brain they possessed any trace of the adaptations which have become so pronounced features of the human body. The life-periods and the rate of reproduction of this ancestral stock must have been of the anthropoid order, namely, about seven generations to the century.

In the period postulated by Dr. Gregory for man's differentiation there would have been some 70,000 generations. The representatives of mankind we encounter by mid-Pleistocene times have already a brain which has three times the volume of the chimpanzee brain. Is it pos ible to con eive a brain like that of the chimpanzee, although constituted upon the same structural and functional plan as is the human organ, attaining a human standard in the course of 70,000 generations? It is true that the discoveries of Dr. Ariens Kappers have shown that the countless myriads of nerve units which make up the human brain are, during the period of development, controlled and grouped by a mechanism the nature of which we can only gu ss at as yet. Making all allowances on this score, the reviewer cannot conceive the possibility of the extreme structural and functional complexity of the human brain having been evolved from an anthropoid stage in the course of 70,000 generations. While Dr. Gregory is inclined to accept our present knowledge of the geological record at its face value and trace man's origin from an anthropoid of the mid-Miocene period, the reviewer would make allowances for the great blanks in our geological record, which further discoveries will make good, and assume a pre-Miocene date for the divergence of the phyla of man and great anthropoids. It is very difficult to believe that the human brain arose as mushroom-like growth.

Those who have made systematic attempts to determine the evolutionary relationship of one animal form to another know well that it cannot be settled on the evidence of one set of organs; all the structural systems of the body have to be taken into account. Often the evidence of one system—such as that of the teeth, which go with the alimentary system—will seem to clash with or contradict the evidence of other systems. Dr. Gregory is too experienced an evolutionist to make a mistake in this respect; whenever possible he supports or modifies the conclusions reached on dental evidence by appealing to testimony afforded by other systems of the body. Even when this is done it becomes abundantly clear that evolution has not worked on the body of man, ape, or of any animal form whatsoever in a simple and straightforward manner. For example, in that primitive but aberrant primate Tarsius, the embryo establishes itself in the maternal womb in exactly the same manner as do the developing ova of man and anthropoids, and yet the monkeys of the New and of the Old World, which have a simpler type of placentation, are yet infinitely

more akin to man and anthropoids in a structural and evolutionary sense than is Tarsius—in spite of this and other unexpected human likenesses possessed by the latter. To account for the irregular distribution of certain characters possessed by man and Tarsius, Prof. Wood Jones has put forward the claims of owl-eyed Tarsius to pose as one of man's near relatives.

The relationships of Tarsius to man, says Dr. Gregory, "are plainly very indirect and must be traced backwards along gradually converging lines to the primitive tarsioid stocks, which gave rise at different times and at different places to the higher groups of primates." As it has a bearing on such problems as the irregular distribution of the human mode of placentation among the primates, Dr. Gregory quotes with approval a principle enunciated by Dr. Henry Fairfield Osborn in 1908 and "familiar to all close students of mammalian phylogeny, namely, that identical characters are often developed by divergent descendants of a common stock." To the master morphologists of our studenthood days such a statement would have sounded heretical or metaphysical, but to those who are familiar with the complex mechanism of hormones, which regulate the growth of diverse structural elements so that they are moulded to serve a common functional purpose, this statement, made by one who has given a lifetime to the observation of fossil forms, has become of easy acceptance to those who are studying the development and growth of living forms. Our difficulties of accounting for the composite make-up of the human body and of that of his congeners, the anthropoid apes, will disappear once we have mastered the growth mechanisms which lead to the creation of structural modifications and the suppression and perhaps resuscitation of old features.

The reviewer has merely noted here the chief conclusions which years of careful toil have permitted Dr. Gregory to formulate concerning man's origin. The main value of the work he has now published is to provide students of the higher mammalian forms with an indispensable dictionary for the interpretation of dental hieroglyphics. Out of a restricted alphabet, Nature has fashioned teeth into a most elaborate and significant language. How these elements are manipulated so as to provide a profusion and variety of dental forms we do not know but it is clear to the least initiated that upper and lower teeth have to be so fashioned, while still embedded in the gums, that when they come into place in the jaws they will fit each other just as a key does its lock. There must be a correlating mechanism at work to harmonise the bite of opposing cusps. Of this Dr. Gregory is fully cognisant, but we regret that he has not abandoned the confusing system of naming the cusps of molar teeth introduced by Dr. Osborn. In this system the names given to the cusps of upper molar teeth are reversed when applied to the cusps of lower teeth—a method with all the perplexing attributes of a reflected image. Besides, as Dr. Gregory has frankly admitted, the system, which has served a good purpose in its time, is really founded on an erroneous interpretation.

Another small and personal grudge the reviewer may also give vent to—the introduction of the new-fangled nomenclature for the old and well-established generic names we have hitherto been accustomed to give to apes and monkeys. But the reviewer's last words must be those of admiration and of thanks for a standard work.

A. KEITH.

A Reflective Observer.

A Philosopher with Nature. By Benjamin Kidd. Pp. vii+211. (London: Methuen and Co., Ltd., 1921.) 6s. net.

MR. BENJAMIN KIDD was a keen observer of Nature, particularly interested in the problems of animal behaviour and all that throws light on evolution. This volume is a collection of his essays; with the exception of the first two, which deal very attractively with the birds of the Severn estuary, they have been previously published in serials. But in collected form they are very welcome. In all cases there is a characteristic reflective note: What is the deeper significance of this or that occurrence? The primitive language, among birds for example, is undoubtedly a language of the emotions, but it is interesting to notice that it is often a kind of *lingua franca* understood even by widely different species. The young of the mallard, which has probably been the most universally hunted creature on earth, nestle on the observer's bare feet without the slightest instinctive fear. "You take one of them in your hand, and this heir of the ages of the blood-feud shows no fear of you, even tilting its little beak to look inquiringly in your face; evidently thinking no evil, to all appearance hoping all things and believing all things, but certainly quite willing to take you on your merits for good or evil entirely without prejudice." The mother bird is on a tussock near by, "chattering with emotion, every feather quivering with excitement. The hold of the Great Terror of Man is upon her. In a few days, nay, in a few hours, she will have taught it to them, and they will have passed irrevocably into another world." Character is a product of "Nature" and "Nurture."

An interesting experiment was made with a colony of humble-bees which Mr. Kidd kept on his window-

sill. He carefully removed part of the waxen covering of one of the little groups of larvæ, inserted a grub taken fresh from a hive, and covered the whole again roughly, "expecting that the bees would complete the repairs, and so seal up the intruder with the others. But they were not to be cheated in this way, and they would not repair the broken wax until they had smelt out the stranger, whom they dragged out and carried outside the nest, after which they replaced the breach in the usual way." He made the experiment several times, but with no better success. He then placed some hive-bee eggs among a little group just deposited by the humble-bee queen. The bees seemed to be rather puzzled. "One or two of them took them up somewhat aimlessly, and again replaced them as if they hardly liked to openly accuse their sovereign of misconduct, which they seemed to suspect." After some hesitation they proceeded, apparently with considerable relish, to eat the eggs. "So appreciative did they become of the flavour of these new-laid eggs that they would soon accept them readily when I offered them at the end of a needle."

Observations on a captive queen humble-bee supplied with an empty nest were also interesting. She spent several days beating against the window-pane and then gave it up entirely; she showed great interest in brightly coloured objects like brass handles, gilt labels on books, and waistcoat buttons. But she was particularly intrigued by the keyhole of the door, into which she would try to squeeze herself. Apparently it "suggested" the opening into an underground nest.

In the essay on hares there is an interesting paragraph. "It is a moot question whether the hare is a rabbit which has taken to the open or the rabbit a degenerate hare which has obtained comparative safety by taking to a stupid life in the earth. It is an interesting fact in this connexion, and one not often remarked on by observers, that a hare, if it finds an obstacle it wishes to get rid of, will naturally scratch with its front legs with considerable strength and with exactly the same movement as a rabbit. Thus, although the hare lives in the open grass country, never takes to earth, and much dislikes ground infested by rabbits, it has to all appearance latent in its muscles the beginning of an instinct which might be developed into the rabbit's capacity for burrowing."

Of its kind the picture of a midsummer night is difficult to beat; it is as well drawn as Richard Jefferies could have done it. Take the sounds: the churr of the night-jar, calling to his mate; the undertone of the hundred rills and the swollen river; the warning stamp of rabbits that have been disturbed in their feeding; the strident love-note of the corn-crake; the shrill cry of the partridge; the nightingale singing to his mate on her nest; and then the larks, the thrushes, the twittering swallows as the fringes of the night overlap the coming day. It is not merely a well-drawn picture; it is a reflective appreciation.

What Mr. Kidd has to say about animal behaviour is always interesting. Obeying the law of parsimony he will press the simplest re-description as far as it will go, and yet he cautions us that "the more the subject is closely studied the less the observer finds himself inclined to accept ready explanations." A young sheldrake, fed on dry ground, went through a kind of dancing or prancing movement, stamping rapidly on the floor with its feet. Darwin connected this with the sheldrake's habit of patting the sand or mud near the worm-burrows on the seashore flats. The stamping is supposed to "make the worm come to the surface," and so the sheldrake keeps on stamping. But Mr. Kidd points out that it is the way of young wild duck in general to stand in the shallow water and stamp gently and rapidly on the muddy bottom. This makes an eddy bringing up food-particles which are then seized and devoured. Three-days-old ducklings, hatched under a domestic hen, exhibit the movements to perfection. Perhaps the sheldrake's stamping is merely a slight modification of a piece of instinctive behaviour general among ducks. But in the opposite direction, Mr. Kidd makes out a good case for refraining from any simplicist interpretation of the behaviour of a collie dog. We fail utterly unless we take into account its ancestry, for it was one of a pack, a social unit. "The dog has probably still some sort of conception of his place as member of a co-operative group, and of his master as the wise and resourceful leader of it." The other essays discuss sea-trout, eels, frogs, birds, squirrels, and the like. All are illuminating and all are delightful.

Metallography in the Workshop.

Steel Thermal Treatment. By J. W. Urquhart. Pp. xv+336. (London: Crosby Lockwood and Son, 1922.) 35s. net.

NEARLY all the books which have hitherto been written on the heat treatment of steels are the work of metallurgists. The interesting thing about the present work is that it has been written by a man engaged in the production of machinery and various steel components and tools in his workshops in Leicester. As he states, he has been forced to put into practical use all the recently introduced processes employed in

the heat treatment of steel. Many other tool makers have been in the same position. It has, however, been left to Mr. Urquhart, not merely to make a study of the processes involved, but to write a book on them from a practical engineering view-point. In doing this he has rendered a service to his brother engineers which they will probably not be long in recognising, for he has written his book in language which is as free from technicalities as possible.

The time has gone by when steels as received from the makers were forthwith worked into machines, without any preliminary treatment, and when it was not realised that a thermal process could add enormously to their physical strength and effectiveness. In consequence there has been a revolution in the engine and machine building trades within the last few years, which is only realised by the men engaged in those trades. As the author points out, not only have great improvements been introduced in the treatment of well-established carbon steels, but they have been followed by a remarkable development in the use and heat treatment of alloy steels. These advances have necessitated the application of better systems of applying heat and measuring the temperatures produced, and these in their turn have led to the introduction and development of electrical methods of heating, which are capable of a higher degree of control and accuracy.

The early chapters of the book deal with the recent developments in metallography as applied to steels. The author has mastered the theory of the iron-carbon equilibrium, as applied to both carbon and alloy steels, and this is one of the best parts of the whole book. As he points out, one of the most remarkable effects of alloying nickel with mild steel is the lowering of the temperature of the Ac1 range, an effect which means diminished cost of working the steel, a greater margin of safety against over-heating, increased ductility, toughness, and resilience in the finished product. The physical characteristics of steels and testing methods are next described, and these are followed by an outline of thermal processes. Chapters on furnaces and their methods of working come next, and a very good account is given of pyrometers and their application to the thermal treatment of steels. Methods of case-hardening, both by solid and gaseous reagents, are next described, and these are followed by details of the various methods of quenching. Later chapters deal with various types of tools and typical heat treatments, and in the last two chapters accounts are given of the thermal treatment of high-speed tool steels and stainless steels.

To some extent the book is an attempt to co-ordinate the work of the laboratory with that of the engineer's hardening department; and with this end in view, the author has included a series of photomicrographs illustrating the structures of steels at various stages of heat treatment under workshop conditions. He has availed himself of the experience of well-known metallurgists, such as M. Guillet and the late Prof. Howe on the academic side, and of Sir Robert Hadfield, Mr. S. Brayshaw, and Prof. Giolitti on the practical side. There is no doubt that the volume will be widely welcomed by practical men, and it should do much to raise the standard of the scientific heat treatment of tools and machine parts.

H. C. H. C.

Mosquito Control.

Mosquito Eradication. By W. E. Hardenburg. Pp. ix+248. (New York and London: McGraw-Hill Book Co., Inc., 1922.) 15*s*.

IN this small book the author gives a clear and concise account of the measures which have been found successful in controlling mosquitoes in America. The brilliant results of the anti-mosquito work in Havana and the Isthmus of Panama have been fully appreciated in the United States. Dr. G. A. Le Prince, formerly Chief Sanitary Inspector, Isthmian Canal Commission, wrote, in the Annual Report, U.S. Public Health Service for 1920, "The public view-point has changed; villages, towns, county and state officials, as well as business corporations and railroads, now realise the extent of the large preventable financial loss they incur each year. . . . The people have been watching the campaigns undertaken, and throughout the country they are becoming more and more interested in having their own community and state undertake this work. . . . This calendar year, 101 places are doing work under the supervision of the Public Health Service, and have already appropriated $280,000 therefor."

The modern methods of mosquito control are merely elaborations of those originated by Sir Ronald Ross in the East and by General Gorgas in the Canal zone and Cuba; they have already been described very graphically by Le Prince and Orenstein. But Mr. Hardenburg, who is a sanitary engineer, has treated the subject from a somewhat different point of view from that adopted in "Mosquito Control in Panama." Descriptions are given of the more important American culicine and anopheline mosquitoes. These, though brief, are sufficient to enable a sanitary officer to recognise most of these insects that he is likely to meet with; the information given in the body of the book is supplemented, in an appendix, by a more technical key for the identification of both larvæ and adults.

A good account is given of the preliminary survey work that has to be done before actual operations against the mosquitoes can be commenced. Mr. Hardenburg insists upon the importance of a vigorous propaganda to arouse public interest, and explains, with some humour, how to induce newspaper editors and the "motion picture houses" to "boost" the work.

Drainage of swamps, pools, and salt marshes is dealt with very thoroughly; and detailed directions are given for the construction of drains by handwork or by machinery, for the laying out of a system of tile drainage, and for the construction of tide gates and sluices.

The use of oil and other larvicides, with its advantages and disadvantages, is fully considered; and a whole chapter is devoted to the use of fish to control the mosquitoes. The author writes with enthusiasm on this latter subject, but adopts a more judicial attitude towards the proposal to establish "bat-roosts." The problem of how to deal with the mosquitoes which breed in rice-fields seems to be still unsolved, at least in countries where the people insist upon having rice cultivation near the villages. The habits of the different species of Anopheles, and especially their choice of breeding-places, are so varied that experience gained in one country is not sufficient for dealing with the conditions met with elsewhere. Now, however, thanks to this book, to that of Le Prince and Orenstein, and to Dr. Malcolm Watson's "Prevention of Malaria in the Federated Malay States," public health officers in the tropics are well provided for.

Mr. Hardenburg's book represents the views of a practical man. It can be recommended with confidence to all those who have to deal with sanitation in malarious countries.

The value of the book is much enhanced by the many excellent illustrations with which it is adorned.

H. J. WALTON.

Our Bookshelf.

Das feinbauliche Wesen der Materie nach dem Vorbilde der Kristalle. Von Prof. Dr. Friedrich Rinne. 2 und 3 erweiterte Auflage. Pp. viii + 168. (Berlin: Gebrüder Borntraeger, 1922.) 10*s*. 4*d*.

THE new edition of Prof. Rinne's book is considerably larger than the first edition, and presents an altogether wider outlook on the fine structure of matter as exhibited in crystals. The whole work is enriched by an originality of treatment which renders it eminently readable and suggestive. Moreover, the excellent portraits of von Groth, Haüy, Schoenflies, Fedorov, Tschermak, von Laue, Debye, Scherrer, Sir William Bragg, and W. L. Bragg give it an altogether special interest. A reproduction of Albrecht Dürer's picture "Melancholie" is also given, in which the representation of a huge crystal occupies a prominent place, the inference being that Dürer was oppressed by the idea of the hopelessness of man's ever rising to the comprehension and explanation of a natural phenomenon so wonderful and remarkable as that of crystallisation. If Dürer lived to-day, however, how different would be his picture! Its title might well be "Hope," or even "Achievement," rather than "Melancholie."

It is this extraordinary success of recent crystallographic and physical research, and particularly that brought about by the use of X-rays in elucidating the arrangement of the chemical atoms in crystals, that forms the main theme of Prof. Rinne's book, and he regards the whole achievement in its more fundamental aspect, as having revealed the true nature of the fine-structure of solid matter. The book is full of illustrations and diagrams of an original character, including many of the X-radiograms of crystals due to Prof. Rinne's own industry. It is a book of very special merit, and one of the most suggestive and far-seeing that have appeared since the inauguration of these fruitful new methods of research.

A. E. H. T.

Elementary Hydraulics for Technical Students. By Prof. F. C. Lea. Pp. vii + 224. (London: E. Arnold and Co., 1922.) 7*s*. 6*d*. net.

DR. LEA's larger work on hydraulics has long been regarded as an authoritative treatise, and the present volume will be welcomed by many who have felt the need for a less comprehensive work. Beginning with clear accounts of fundamental principles, the questions of the flow through orifices and over notches and weirs are discussed. Next follow the flow through pipes and channels and the methods of gauging the flow of water. Vanes, water-wheels, turbines, and pumps are then considered, and the volume closes with a chapter on hydraulic machines. The treatment throughout is simple, which will render the book suitable for use in technical schools; the drawings are well executed, and the text is very readable. A commendable feature is the description of many experiments which may be carried out on a comparatively small scale with inexpensive apparatus. Any student who works systematically through the experiments described will gain a very fair working knowledge of the methods employed and of the manner in which the results are reduced. The book also contains a number of well-selected exercises, with answers; to some of these exercises hints are appended for their solution, while others are left to the student. Hydraulics is not an easy subject to author or student, and Dr. Lea is to be congratulated upon the present volume, which cannot fail to be of service to both teachers and students.

The Czechoslovak Republic. By Jaroslav Císař and F. Pokorný. Pp. vi + 218. (London: T. Fisher Unwin, Ltd.; Prague: Orbis Publishing Co., 1922.) 9*s*. net.

THE authors of this volume aimed at compiling a complete handbook to the new state of the Czechoslovak republic and have published an English edition in the hope of spreading a knowledge of their country. There are chapters on the history, topography, population, political organisation, natural resources, industries, trade, transport, etc., with appendices of statistics

and a well-printed, if rather small-scale coloured map. The notes on topography are very brief, covering scarcely two pages, while climate is dismissed in a few lines. More consideration of these fundamental aspects of the economic life of the country would enhance the value of the book.

Of all the new or newly constituted states of Europe probably none has greater possibilities than Czecho-slovakia. Its central situation, varied resources, and rich mineral endowment combine to promise a bright future. Racially also it has fewer thorny problems to solve than most of the new states. Czechs and Slovaks together comprise 68 per cent. of the population, and the only considerable non-Slavonic element is 22 per cent. of Germans, mainly in Bohemia. At the same time the great difference in cultural status between the Czechs and Slovaks, which is emphasised by the comparative lack of communication between their respective countries, is a hindrance to the consolidation of the State. The government is fully aware of this difficulty, and is facing it by the improvement of communications. The section of the Elbe from Aussig to Neratovice has been canalised and operations are in progress as far as Pardubice. From there a canal, 110 miles long, will be built to Prerau on the Beczwa in Moravia. A Danube-Oder canal is also under consideration.

R. N. R. B.

Technical Electricity. By H. T. Davidge and R. W. Hutchinson. Fourth edition. Pp. xii+514. (London: University Tutorial Press, Ltd., 1922.) 10*s.* 6*d.*

THE object of the authors of this volume is to give a clear exposition of physical principles and to show how they are applied in engineering practice. This is done satisfactorily, and we think that the volume will prove useful to engineering students in the first and second year of their course at a technical college. Engineering practice and phraseology change rapidly, so it is difficult to keep an engineering treatise absolutely up-to-date. For example, the phrase "mean spherical candle-power" is rapidly becoming obsolete. Engineers now use the much more sensible phrase "the average candle-power"; similarly a "half-watt" lamp is now termed a "gas-filled" lamp. It is not strictly correct to say that the international candle-power "is now defined as an illuminating power equal to one-tenth of that of the Harcourt-Pentane lamp." When engineers refer to the international candle they mean the unit of luminous power maintained by the National Physical Laboratories of France, Great Britain, and the United States of America. The Hefner-kerze is used by Germany and Austria, and its numerical value is nine-tenths of that of the international candle. Hence the candle-powers given by lamp manufacturers in Germany are expressed by larger numbers than if they were expressed in international units. This is to their commercial advantage. We were surprised that the international standards for the resistance and temperature-coefficients of pure annealed copper are not given, as they are of fundamental importance in electrical engineering. We hope that the wire gauges, the table for the resistance of copper wires (temperature not stated), and the tables of fusing currents will be omitted from the next edition.

Notes on Qualitative Analysis: Concise and Explanatory. By Dr. H. J. H. Fenton. Supplement. Pp. v+155-202. (Cambridge: At the University Press, 1922.) 3*s.* 6*d.* net.

THIS pamphlet forms a supplement to Dr. Fenton's well-known "Notes on Qualitative Analysis." The more important and characteristic reactions are given of the rarer elements of more general interest which can be identified by chemical tests. References to "spectra," without any details, are made. No description is given of possible methods of separation. In arranging the elements according to alphabetical order, their chemical relationships are quite obscured, and the information conveys the impression of isolated snippets. The selection of the inorganic and organic compounds is, as the author emphasises, quite arbitrary: one notices more particularly the substances studied by Dr. Fenton himself. Although the book may prove useful to teachers who have not access to the larger treatises, its lack of system and reasonable completeness will somewhat diminish its value as compared with existing manuals of qualitative analysis such as that of Treadwell.

The Fishing Industry. By Dr. W. E. Gibbs. (Pitman's Common Commodities and Industries.) Pp. viii+135. (London: Sir I. Pitman and Sons, Ltd., 1922.) 3*s.* net.

A VERY concise and comprehensive account of the sea-fishing industry in general is contained in Dr. Gibbs's little volume. There are chapters on the natural history of the edible fishes, molluscs, and crustacea, and on the methods of fishing, but the distinctive parts of the book are those that deal with the mode of fish-curing and conservation, and with the utilisation of by-products. Written with an evident personal knowledge of the processes described, these chapters make a really important contribution to the literature of the sea fisheries.

J. J.

Manuel d'océanographie physique. Par Prof. J. Rouch. Pp. 229. (Paris: Masson et Cie, 1922.) 15 francs.

CAPT. ROUCH's book is a well-balanced account of oceanography, treated almost entirely from the physical point of view. The first part deals with methods, soundings, the physics and chemistry of sea-water, the study of currents, tides, and tides and the observation of ice-formation. The second part deals in the usual way with the general results of oceanographical investigation. The book is a small one, but it is very concise in its treatment, and it is well illustrated.

Practical Tanning. By Dr. Allen Rogers. Partly based on the Third Edition of "Practical Tanning," by Louis A. Flemming. Pp. xxv+699. (London: Crosby Lockwood and Son, 1922.) 45*s.* net.

DR. ROGERS is well known for his writings on chemical technology, and as an account of recent American practice his book will prove interesting to English technologists. It deals briefly with all branches of the subject, and is illustrated. The section on analytical methods is brief, but most of the important determinations are covered. A short account of synthetic tanning materials is given.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

A Quantum Theory of Optical Dispersion.

WHEN a theory is framed trying to explain a discrepant system of facts, it is a necessary process of thought to take some branch of the theory as more completely true than the rest, and to adjust the remaining parts in such a way that they will fit in with this base, though they may still conflict with one another. This has certainly been true of the quantum theory; the speculations connected with it have as their base the law of the conservation of energy. Now a critical examination of fundamentals does not by any means justify this faith. It is, of course, a fact of observation that, in the gross, energy is conserved, but this only means an averaged energy; and as pure dynamics has failed to explain many atomic phenomena, there seems no reason to maintain the exact conservation of energy, which is only one of the consequences of the dynamical equations. Indeed it is scarcely too much to say that had the photoelectric effect been discovered a century ago it is probable that no one would ever have suggested that the status of the first law of thermodynamics was in any way different from that of the second. On the other hand, Bohr's theory, and especially Sommerfeld's extension of it, have given great encouragement to the belief that in dynamics lay the way to the complete truth, so that in consequence of the triumphs of that theory there has been little thought in other directions. Another impediment is that our whole ideas are saturated with the principle of energy, so that denying it leaves scarcely any foundation from which to start.

Now there is another field of phenomena which forms a consistent whole, but at present only fits into the quantum theory with a good deal of difficulty —that is, the wave theory of light. Interference and diffraction are completely explained by a wave theory, and it would seem almost impossible to devise any really different alternative which would account for them. Here is a base which seems to be free from the objections which attach to energy, and I have therefore been examining the consequences of fitting it in with those parts of the Bohr theory which seem to be most completely established. The result is what I believe to be a satisfactory theory of dispersion—one of the weakest points in the quantum theory[1]—and a great promise of future extensions in other directions.

We shall assume then that the wave theory gives a correct account of events *outside matter*, and it is convenient to take over the terminology of the electromagnetic theory, provided we remember that "electric force" is only to mean "light vector," and that we are not prescribing how the electric force will affect the behaviour of atoms or electrons. The assumption brings with it of course the exact conservation of energy in the æther; it is in interchanges with matter that it need not be conserved. When a wave passes over matter there is a mutual influence, and without any inquiry into what happens to the matter, we can say that it is inconceivable that the effect on the æther should be anything

[1] The difficulty is that the standard theory indicates a dispersion formula involving the frequency of the electron's motion in the atom which is quite different from its absorption frequency.

but in the form of an expanding spherical wave. Every such wave can be described in terms of spherical harmonics, and the simplest is the one corresponding to the harmonic of zero order. In this the electric force vanishes at two poles and is elsewhere along the lines of longitude and proportional to the cosine of the latitude, while the magnetic force lies in the circles of latitude. This is the type of wave given in the classical theory by a Hertzian doublet vibrating in a line, and it proves unnecessary for our theory to postulate that any more complicated type is emitted by the atom. If x is the direction of the pole of the wave, then at x, y, z, at a great distance r from the atom, the wave is given by:

$$\left.\begin{aligned} E_x &= -\frac{r^2-x^2}{r^3}f(t-r/c) \\ E_y &= \frac{xy}{r^3}f(t-r/c) \\ E_z &= \frac{xz}{r^3}f(t-r/c) \end{aligned}\right\}, \qquad (1)$$

Next, borrowing from the Bohr theory, we shall assume that when an atom is struck by a wave, there is a certain chance that the atom should emit a secondary wave of the above type. With these assumptions it is possible to argue inductively from the observed fact that if incident waves are superposed the result can be found by an addition of their effects and from the known form of the dispersion formula. There is no need to give the argument, but only its final result. The complete statement of this for unpolarised waves is rather more complicated, but the essential points of the theory are fully represented in what follows.

When a wave, polarised so that the electric force is along x, strikes an atom at the origin there is a chance $A_n(\partial E_x/\partial t)dt$ that in the time dt it will excite the atom to emit a spherical wave of the type (1) with f of the form $\alpha_n e^{-\lambda_n t}\cos k_n t$. *Here* A_n, α_n, λ_n *and* k_n *depend only on the nature of the atom and not at all on the incident force*; λ_n is supposed to be small. Of course $\partial E_x/\partial t$ may be negative; in this case we shall suppose that there is a chance $A_n(-\partial E_x/\partial t)dt$ for the emission of a wave $-f$. We shall be able to treat both cases together and need not make the distinction. The subscript $_n$ indicates that we suppose there are several different ways in which the atom may be excited, each with a separate chance for it.

Consider a simple case, a monochromatic wave polarised along x and advancing along z, which strikes a group of N atoms at the origin. Let the wave be $E_x = H_y = F\cos p(t-z/c)$. The number excited in the interval dt will be $NA_n(-Fp\sin pt)dt$. Consider the secondary wave crossing the point x, y, z, at the time $t+r/c$. This is due to all the atoms which were excited before the time t. The number excited in the interval ds at a time $t-s$ is $-NA_nFp\sin p(t-s)ds$ and each of these will at the time t be giving a wave typified by $f=\alpha_n e^{-\lambda_n s}\cos k_n s$. So the total effect will be a wave which at the time $t+r/c$ at x, y, z has an x-component

$$\begin{aligned} E_x &= -NA_nFp\left(-\frac{r^2-x^2}{r^3}\right)\int_0^\infty \sin p(t-s)ds\,.\,\alpha_n e^{-\lambda_n s}\cos k_n s \\ &= NA_n\alpha_n\frac{r^2-x^2}{r^3}F\frac{p^2}{k_n^2-p^2}\cos pt, \end{aligned} \qquad (2)$$

provided that λ_n is taken as small. The averaging has entirely blotted out the frequency of the atoms and left only that of the incident wave. Now on the classical theory, if there is a group of N_n electrons

which have a natural frequency of vibration $k_n/2\pi$, the wave they scatter is given by

$$E_x = N_n \frac{e^2}{mc^2} \frac{r^2 - x^2}{r^3} F \frac{p^2}{k_n^2 - p^2} \cos pt.$$

So if we identify $N_n e^2/mc^2$ with $NA_n a_n$ the expressions are the same. But the only difference between the phenomena of scattering and of the refractive index lies in the matter of allowing for the mutual influence of the atoms, an influence exerted by the waves they send out and therefore the same on both theories. So we may at once say that from our result will follow the dispersion formula of Lorentz

$$\frac{3(\mu^2 - 1)}{\mu^2 + 2} = \Sigma_n \frac{4\pi N c^2 A_n a_n}{k_n^2 - p^2}.$$

From the linear way in which the chance of excitation depends on the incident force, it follows that the average effects of superposed waves is additive; in other words, the atoms act as Fourier analysers, sort out the harmonic components of an arbitrary incident wave and refract each component in the proper degree. In all cases the characteristic frequency with which the waves are really emitted will entirely disappear by averaging.

It will be necessary to consider the balance of energy which is nearly but not quite exact, but the present simple equations are not suited for this; they fail to give the balance even in the classical case, and there it must occur. This question is better treated in connexion with absorption. The problem is complicated by the fact that the excited wave may possibly have a phase differing slightly (it may only be slightly) from that of a cosine. I have assumed the form of the damping factor as $e^{-\lambda_n t}$ only for convenience; all that is necessary is that the infinite end should be unimportant. An alternative is to suppose that the wave is undamped but that there is a chance $\lambda_n dt$ in every element of time dt that it should stop. We have only discussed waves polarised along the x-axis and have supposed that the excited waves have this axis as pole; for the general case the formulation must be somewhat changed, but it would take too long to state and prove the modification here. The essential points of the theory are not altered, and it also appears that there should be no particular difficulty in fitting double refraction and rotatory dispersion into our scheme.

A theory of dispersion is not of course complete without including selective absorption. If λ_n is retained in the integration of (2) the result is an expression practically the same as that given in the classical theory when a damping factor is included. Observe that on the present theory, when the forced period approaches the natural, there is no increase either in the number of atoms excited or in the strength of the waves they send out. The whole change is due to the greater efficiency with which they reinforce the primary beam. Our theory gives no explanation of the mechanism of conversion of radiant energy into atomic heat, any more than does the classical theory with its damping factor. The conversion is probably better studied by the consideration of other cases of absorption, such as metallic reflection, and our method of argument, applied to this last, should certainly give interesting results. We shall have to find what emission of spherical waves will diminish the æthereal energy when superposed on the incident wave. Thus a wave like that for dispersion would do for metallic reflection, if the phase is suitably altered, or possibly we may suppose that the wave is again in the form of a cosine, but that the chance of excitation is now proportional to E_x instead of to $\partial E_x/\partial t$. It seems likely that a study of the optical constants of metals would throw light on this question. Afterwards it would be necessary to examine the balance of energy between æther and matter, and this might help in understanding the mechanism of the process.

We may now review how these speculations will modify the accepted theory. As we have made no assumptions as to what goes on inside the atom, we can take over the whole of the dynamics of stationary states. We suppose that an atom is usually in its lowest quantum state. The motions of the electrons will sometimes lead to a favourable configuration, and when this occurs in the presence of a changing electric force, there is a chance that the atom may be jerked into a condition in some way associated with one of its higher quantised states. It at once starts radiating with a frequency corresponding to the return from that state to the lowest. Dispersion throws no light on the amplitude of the wave, for in the formula it always occurs multiplied by the probability factor A_n. It is rather tempting to suppose that it actually goes into the higher quantised state, and then gives a wave of such amplitude and length that, but for the interference with the incident light, it would emit energy $hk_n/2\pi$. If this is so we may perhaps extend our theory to cover pure emission; for, though we have not postulated any precise relationship between electric force and electrons, it seems inevitable that there should be a rapidly changing electric force near a moving electron, and this force would have a chance of jerking the atom into its higher state. On the other hand, difficulties are raised in other directions. For the radiation must be immediate and therefore the state would not really be stationary at all, and the accepted theory of specific heats requires that a molecule should be able to remain in its higher states. In any case there is a clear contradiction to the principle of energy, but the phases of the outgoing waves are so adjusted that for cases of pure scattering or refraction, on the average, as much energy goes out as comes in.

There are many other points that will require attention. In the first place the refractive index is closely related to the dielectric constant. Now though it is quite proper to treat the dielectric constant as a limiting case of refraction, yet it can be regarded electrostatically and it will be necessary to see the physical meaning of this aspect. Again it is possible to count the electrons in the atom by X-ray reflection, and it follows that there must be a relation between the e^2/mc^2 of the classical theory and our $A_n a_n$. In this connexion I owe to Prof. P. S. Epstein the suggestion that the theory will explain the defect observed in the scattering of hard γ-rays below that predicted. Here the wave-length of the incident light is much shorter than the distances between the electrons and the incoherent waves cannot recombine in the way they do under the classical theory. Lastly, it will be necessary to re-examine the deduction of the formula for black radiation, for all present proofs are founded on theorems following out of the conservation of energy.

In view of the great number of problems that are suggested and the probability that it will take a considerable time to deal with them, it appeared to me that it might be of interest to publish this preliminary account of a very incomplete theory.

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Interspecific Sterility.

DR. BATESON'S letter on interspecific sterility in NATURE of July 15, p. 76, has given rise to an interesting discussion in later issues, which may be summarised thus :—

Sterility between wild species is not nearly so common as was formerly supposed, yet it undoubtedly occurs frequently, both between species with the same number and with different numbers of chromosomes. The cause of this sterility has not yet been made out with any degree of certainty. On the other hand, crosses between domestic races are, almost exclusively at least, perfectly fertile, although Dr. Gates rightly points out that sterility may often be expressed in lethal factors and that lethal factors are of common occurrence in Morgan's "domestic" races of Drosophila for instance.

Dr. Bateson's starting-point is his belief, that domestic races as well as species in Nature have arisen by some process of transmittable variability, let us say by mutation. At least, on no other assumption can I explain his sentence (*l.c.* p. 76) :

"In contemporary variation we witness the origin of many classes of differences, but not this (*e.g.* interspecific sterility) ; yet by hypothesis it must again and again have arisen in the course of evolution from species of a common origin."

Geneticists are aware that this view is not mine. According to my view two genotypically different gametes are required to give rise to new forms : domestic races as well as natural species arise by crossing. If this is the case—and nobody will deny that, at least in the production of "races," crossing plays a most important rôle—there is no cause to assume that sterility has ever "arisen" from fertility in the course of evolution. We have, for the present, to be satisfied with the establishment of the fact that some gametes, differing in constitution, after crossing give rise to wholly or partly sterile progeny, while others give fertile progeny only.

As there is no reason to assume that our domestic products are the result of crosses only of such wild species as from the start gave exclusively fertile progeny—although, as we shall see, such crosses may indeed have been favoured—it follows that the general inter-racial fertility of domestic products must have been "acquired." Consequently the problem under discussion is not how sterility arose from fertility, but how a form-group in which both inter-racial fertility and sterility occurred, became changed into one, the members of which were all interfertile.

It seems to me that the most simple explanation is offered by the assumption that man from the beginning, for example, from the initial cross or crosses among his animals or plants taken from Nature, in an attempt to domesticate them, has selected the most fertile forms and has continued to do so; in other words, that he has persistently exterminated those forms which were intersterile and kept only those which were interfertile.

While at the present moment intersterility of domestic races might offer considerable advantages, allowing, for example, the cultivation side by side of different varieties of flowers without fear of crossing, there was no such advantage at the very beginning of domestication, when the only object was not to obtain a particular kind but any kind of domestic animal or plant. By this continued selection of interfertile forms, man himself has by now cut off the possibility of obtaining intersterile races.

The following case may illustrate my meaning :

According to my view, our domestic races of fowl, which "without impropriety may, on account of their enormous differences, be compared to natural species," have arisen from a cross in which more than one wild species has taken part. Prof. Ghigi, the well-known ornithologist of Bologna, is of the same opinion, and Dr. Bateson also evidently looks favourably on this view, as he states that he finds it difficult to believe that all races of poultry should have descended from *Gallus bankiva* only. While all races of domestic poultry are, so far as is known, fertile *inter se*, crosses of *Gallus bankiva* and *G. Sonnerati*, or of the former and *G. varians*, give rise, as is well known, to a partly fertile and partly sterile progeny, so that, if our domestic fowl have really arisen from crosses of these wild species, their inter-racial fertility was not primitive, but "acquired" by elimination of the sterile stock.

Thus, according to the views here stated, the starting-point in the formation of domestic races as well as of natural species was the same, to wit, a cross. In those cases in which the product of such a cross was a sterile hybrid, the attempt to originate new races or species was smothered in its birth. Such crosses as gave perfectly interfertile progeny were most acceptable to man, and the cause of the fact that only a very small percentage of the wild species in existence has taken part in the formation of our domestic products may very well be man's partiality for such *ab initio* fertile crosses.

In those cases in which intersterile and interfertile forms arose from a first cross, man selected the interfertile forms, and so obtained the same kind of starting-point for his further efforts as when the first cross had been perfectly fertile from the beginning.

The obtaining of well-defined races from such an interfertile crowd could be attained in one way only, namely, by isolation, and we know that isolation is the alpha and omega of successful breeding.

"Species"-formation in Nature also started from a cross, and Nature's only means of obtaining well-defined form-groups, for example species, also consisted in isolation. Ready-made isolation was presented to Nature by the intersterile forms arisen from a cross ; hence these were favoured, and this accounts for the great percentage of intersterile species in Nature.

To summarise : The starting-point in the formation of races by man and in the formation of species by Nature is the same, namely, a mixed stock of interfertile and intersterile forms arising from a cross.

Man selected the interfertile, Nature the intersterile forms, hence the difference in mutual fertility between domestic races and natural species.

Sterility between species, according to this view, therefore, did not arise from fertility but is the direct result of crossing. J. P. LOTSY.

Velp, November 28.

Occult Phenomena and After-images.

IF the hand be held against a dark background in a very subdued light, coming from behind the observer and falling on the hand, a diffuse glow will be observed round thumb and fingers, frequently uniting the finger tips. A little patience and a moderately clean hand are all that is required to observe the phenomenon

Further, however, if a hand be cut out of white cardboard (which is easily done by placing the hand, with thumb and fingers moderately spread, on the cardboard, tracing the outline in pencil, and cutting round with scissors) and feebly illuminated in the way described, a similar but somewhat stronger glow will be observed. In the case of both the flesh and the cardboard the shape of the glow can be modified by slow movement of the hand.

Such radiations are frequently described by writers on the occult sciences as being emitted by the human body. For example, in the chapter on magnetism in M. de Dubor's recently published "Mysteries of Hypnosis," I read of a doctor who was making magnetic passes over a lady. "The subject was wearing a black dress, and the doctor had his back to the light. Suddenly, in the semi-darkness which surrounded him, he observed a greyish vapour, like the fumes of a cigarette, issuing from the tips of his fingers, and, with especial clearness, from the index and the middle fingers. Moreover, the index fingers of the two hands seemed to be united by a luminous arc or semicircle. . . . Other persons, on the doctor's invitation, drew near and observed the same phenomenon. . . . Then the room was darkened. . . . In the darkness, twelve of the witnesses perceived nothing at all, and the remaining six perceived only very little."

M. de Dubor and the whole occult school explain the glow, or aura, seen round the hand as being due to magnetic emanations from the body (using the word magnetic in a superphysical sense). They appear to think that the phenomenon is more rare than it actually is, and do not treat the case of cardboard hands. For the phenomenon as observed with these, there would seem to be two possible alternative explanations. One is, that the cardboard is occult cardboard, and the scissors hypermagnetic scissors, and that I have unwittingly impregnated everything with induced ectoplasmic activity. The other is that the phenomenon is a retinal (and rational) one, which can be observed whenever a white, or whitish, surface is seen in a feeble light, the visual purple from the actual retinal image diffusing into the neighbouring parts of the retina. Accepting, for argument's sake, the latter explanation (which accounts at once for the fact that nothing is seen in the dark), the effect will be intensified by the restless movement of the eye, which undoubtedly takes place when objects are viewed in unfavourable circumstances.[1] The eye shifts the image into an unfatigued part of the retina, and the after image persists as a feeble glow. Such phenomena have been frequently described by Dr. Edridge-Green in a variety of forms, and I do not claim any particular originality for this prosaic explanation.

But a further very interesting phenomenon can be observed with the cardboard hand, which has not, I believe, been described. If it be looked at fixedly, the ends of the fingers will be seen to vanish intermittently, now one, now the other, while the extended thumb and little finger appear to move up and down, producing somewhat the appearance of a hand opening and shutting. The effect is very striking, and is pleasantly diversified by the complete disappearance of the hand at intervals. This is due either to retinal fatigue, combined with eye movement, or else to the ferro-forcificatory magnetism of the scissors, permeated as they must be with psychic influences and what not. I must leave it to the readers of NATURE to repeat the experiments, and judge for themselves.

Seeing that the festive season (I understand that this is the correct way to refer to Christmas) is upon us, I venture to describe a third occult phenomenon, somewhat analogous to that quoted by Dr. Edridge-Green in NATURE of December 9, p. 772. Two heads, facing one another, are cut out of white cardboard in profile, and observed in a very subdued light against a black background as before. (My heads are about two and a half inches in diameter, and the noses about half an inch apart.) By a delicate manipulation of the scissors one of the heads may be given a feminine character, largely by providing it with back hair. On careful observation the heads will be seen to approach and kiss repeatedly, separating with rapturous amaze after each contact. Like the other phenomena, including M. de Dubor's magnetic fluid, this cannot be observed in the dark, nor, I may add, even heard, in the case of the cardboard heads.

All the phenomena seem to be observed even more easily by myopic people than by myself. A morning's experiment has convinced me that with suitable illumination and white cardboard a very creditable *séance* can be arranged, including auræ, movements and levitations, magnetic emanations, and ectoplasm. This method involves no expense and no hymn singing. Even an atmosphere of reverence is not necessary for the production of the phenomena, although, I admit, the morning of my essay in the occult art was a Sunday morning, which may have had some favourable effect.

E. N. DA C. ANDRADE.

Artillery College, Woolwich,
December 11.

[1] See, *e.g.*, Edridge-Green's "Physiology of Vision." (G. Bell and Sons.)

A Relativity Paradox.

IT is with great diffidence that I enter the relativity controversy, since I know little or nothing of the subject. Ignorance, however, is seldom a bar to the expression of opinions. I understand that the fundamental idea underlying the theory of relativity is that no signal can be transmitted through space at a greater speed than the velocity of light. There appears to me, however, to be a method by which, in theory, it might be done, and since we have trains running past embankments with half the speed of light, and shells with observers inside travelling at even higher velocities, perhaps my observer at A (Fig. 1) may be allowed to have two immensely long triangles made of any suitable material; A signals to B by sliding the two triangles together, one over the other, in the direction of the arrows; the point X, where the two sides intersect, moves towards the observer B, who receives the signal when he observes the point of intersection pass over him. If the angle at X is 10″ and the triangles are moved together at a speed of ten miles a second (an absurdly small speed for a relativist), the signal will be transmitted to B with more than twice the speed of light.

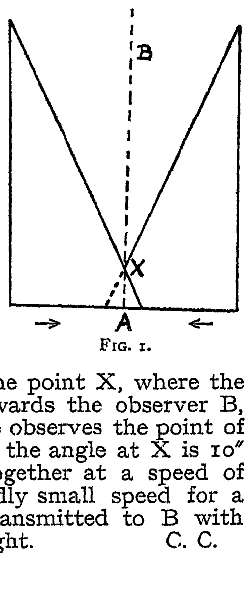

FIG. 1.

C. C.

Is not "C. C." assuming that when A shifts his triangles by tugging at their bases the apices instantaneously start to move? But the impulse would travel from base to apex at a speed far less than that of light, namely, the speed of elastic waves in the material. After the lapse of sufficient time the two triangles would move uniformly and as a whole; and the mechanism provides a good illustration of a recognisable point moving much faster than light. The relativist does not object to this, since the motion of X does not then correspond to anything coming within the definition of a *signal*. The time of signalling from A to B must be reckoned from the moment that A gives the impulse to the mechanism.

A. S. EDDINGTON.

Observatory, Cambridge.

The Track of a Flat Solid falling through Water.

By using a small crystal of silver nitrate as the "flat solid" and acidulating the water with HCl the track becomes visible, as seen in the reproduction (Fig. 1).

Fig. 1.

It was by no means easy to "catch" the effect, and I have to thank two members of the Chemical Society of this College, G. R. Ellis and C. P. Sayles, for all the patience and care taken in obtaining so successful a result.

E. W. Wetherell.

Liverpool College, Liverpool.

Water Snails and Liver Flukes.

Dr. Monica Taylor states in Nature of November 25, p. 701, that further inquiry is desirable in respect to the intermediate hosts of the fluke, as in some districts where water snails are rare or altogether absent, yet in these districts sheep are subject to liver-rot disease. May I add another point? In the Swansea valley, county of Glamorgan, farmers state very definitely, as the result of years of experience, that liming the land increases the liver fluke, for sheep can be run on the rough pastures in the area with slight loss from liver-rot disease, before it is limed; but after it has been so treated the loss from liver-rot disease becomes heavy, sometimes serious. Theories regarding this are many and varied, but the fact remains that the loss from liver-rot in any given area of land is definitely increased after liming. Does liming a wet sour pasture make it more congenial to the water snail? R. Hedger Wallace.

November 28, 1922.

The Cause of Anticyclones.

The steady and persistently high barometric pressure that has prevailed over southern England during most of the autumn naturally causes the desire to know how an anticyclone is produced and maintained in such a situation, but the explanations current in meteorological literature are not for the most part efficacious. It is commonly stated that the high pressure is due to a mass of cold and therefore heavy air above it, but for Europe at least this is in direct opposition to observational results, which show that some three-quarters of the whole mass of air over an anticyclonic area is unduly warm. It is the mass of air over the area that is important; its temperature is quite immaterial, and the real difficulty is to explain why the excess of air does not roll off.

A lecturer demonstrating the gaseous laws must provide himself with a closed vessel in which to confine his gas, and if by any means he spills a pound of mercury on his table he will not expect to find it there in a convenient heap the next day or the next week. The meteorologist, on the other hand, having provided his "polar" air does not proceed to explain why it remains *in situ* and does not rather follow the ordinary law of a fluid finding its own level. The difficulty should be faced and not ignored. Doubtless the equivalent of the lecturer's closed vessel is the geostrophic wind surrounding the anticyclone, but one would like to know how the wind is produced and why and how it is maintained.

W. H. Dines.

Benson, Wallingford, December 1.

German Book Prices.

There has been much comment recently in England and America on the above subject: see particularly an article by Prof. Noyes (*J. Ind. Eng. Chem.*, 1922, 99), and editorial comments in the same journal, 1922, 475.

The following prices are examples:

	Beilstein, bound. Vol. 1.	Vol. 2.	Vol. 3.	Vol. 4.	Stelzner, unbound. Vol. 1.	Vol. 2.	Vol. 3.
England, shillings.	40	38	102	110	24	38	100
Germany, marks.	110	110	280	330	70	104	325

The prices charged to members of the German Chemical Society seem so peculiar that I recently wrote to the society pointing out that much dissatisfaction had been expressed at this state of affairs, and received an answer, from which, as it is too long to insert in full, the following curious passages have been extracted: ". . . Reckoned on the number of pages the prices are much smaller than those of the publications of almost all foreign chemical societies. *The justice of our fixed prices was confirmed a few days ago from Switzerland.* [The italics are mine.] There can be no thought of making foreign and German prices equal so long as we Germans are compelled to spend unnumbered thousands of our depreciated marks to obtain English books . . ."

It is amusing to note the proud reference to the bulk of the journal, which enhances its value so much in German eyes. The diffuseness of their publications is considered in most countries to be a disadvantage; recent complaints were about the quality, not quantity. As to the remark about Germans having to spend many marks to purchase foreign books, the obvious comment is that they need not have printed such a lot of paper money.

Was there not an article in the Treaty of Versailles by which Germany undertook not to impose on British subjects any other or any higher direct or indirect fees, dues, or tax, than are imposed on German citizens?

In the circumstances, I am sure most chemists will agree that until treaties with Germany are something more than scraps of paper, money expended in subscriptions to the German Chemical Society is not much better spent than in buying paper marks.

It is to be hoped that the English and American Chemical Societies will soon be in a position to publish a Dictionary of Organic Chemistry at a fixed reasonable price and in a reasonably terse language.

K. C. Browning.

16 Bridge Avenue Mansions,
Hammersmith, W.6, December 1.

Medical Education.

In Nature for December 9, p. 769, Sir Archdall Reid asks the following question: "But can any one tell us of what utility, practical or intellectual, is the biology which medical students learn—facts about the classification of plants, the vascular system of the sea urchin, the digestive system of the leech, the bones in the cod's head, and so on?"

I am not quite clear whether this question has been propounded to invite answers, or to introduce another of Sir Archdall Reid's favourite discussions on mutations and fluctuations, etc. There is, however, scarcely any need to answer the question. So far as I am aware, the biology offered to medical students *to-day* is very different from that suggested by Sir Archdall Reid in the lines from his letter quoted above. W. J. Dakin.

Zoology Department, University of Liverpool,
December 11.

SIR ARCHDALL REID in his letter to NATURE of December 9, p. 769, tells us that medical students in their biology course learn "facts about . . . the vascular system of the sea-urchin, the digestive system of the leech, the bones in the cod's head, and so on."

Now at this university we have nearly finished the three months' course of zoology for medical students held under Prof. Graham Kerr, and not one of our medical students could answer a question on the subjects named by Sir Archdall Reid. It is a pity, as they are interesting subjects, but there is no room for them in a zoology course for medical students. There is none too much time for the students to learn what they really are taught, namely those parts of zoology which will be, or should be, directly useful to them either as anatomists or medical men.

The point which seems clear is that in the first part of his letter Sir Archdall Reid is asking us for information about "facts" which are not facts, as King Charles II. is said to have done with the Royal Society. What then is the value of his comments based upon these "facts"? J. S. DUNKERLY.

The University, Glasgow.

I HAVE no desire to enter into a discussion with Sir Archdall Reid of the value of the "biology of their own" which medical men "are in a position to construct, and for all practical purposes have already constructed," but it is necessary to point out that his description of the "biology which medical students learn" is not correct. He describes the latter biology as consisting of facts about the classification of plants, the vascular system of the sea-urchin, the digestive system of the leech, the bones in the cod's head, and so on.

Whatever may have been the case when Sir Archdall Reid was a medical student at Edinburgh, not one of the animal types he mentions is now included in the syllabus of elementary practical zoology of the medical curriculum in that university, nor are they included, so far as I know, in the corresponding syllabus in any English university. It is surprising that a member of the medical profession, which is not yet emancipated entirely from the empiricism of earlier times, should write so contemptuously of the leech, once so closely associated with that profession. J. T. CUNNINGHAM.

East London College, Mile End Road, E.,
December 13.

Scientific and Industrial Pioneers.

THROUGHOUT the past year it has been my privilege to contribute week by week to these columns a Calendar of Industrial Pioneers. This now comes to an end. This Calendar and the Calendar of Scientific Pioneers, which appeared last year, contain some 930 names, and the lists are believed to be thoroughly representative of that great and ever-increasing army of workers by whom the secrets of Nature are unravelled and natural riches are made available for the benefit of mankind. In selecting the names to be included this year I was assisted by Dr. W. C. Unwin, Professors Eccles, H. C. H. Carpenter and Abell, Mr. F. S. Marvin, and others, and to them I am indebted for suggestions of which I have been glad to make use. EDGAR C. SMITH.

5 Cotehele Terrace, Devonport.

W. H. Hudson Memorial.

AT a meeting of friends and admirers of W. H. Hudson, held at Messrs. Dent's on November 28, it was agreed that a fitting memorial in stone should be placed in or near one of the sanctuaries in the London parks which should be dedicated to his memory, subject to the consent of H.M. Office of Works.

It was also decided that Prof. Rothenstein's portrait in oils of Hudson should be presented to the Nationa Portrait Gallery subject to the permission of the trustees, and that all monies over and above those spent upon these works should be devoted to the preservation of wild bird life. An executive committee was appointed to carry these proposals into effect.

Hudson's works are imperishable, but we need a national memorial to the great Englishman whose Nature writings are inspired by that change of heart towards wild life which is replacing the old indifference and spirit of destruction. There were two sides to his genius, that of the man of letters and that of the naturalist. Both these elements are, we feel, properly represented in the suggestions outlined, and we earnestly appeal to the public to make it possible for them to be finely executed. Donations should be sent to the hon. treasurer, Mr. Hugh R. Dent, Aldine House, Bedford Street, W.C.2.

R. B. CUNNINGHAME GRAHAM.

Human Blood Relationships and Sterility.

IT is not, I think, generally known that the late Alphonse Milne-Edwards made curious and interesting investigations and suggestions with regard to these matters, but did not live to publish them. A record will be found in Sir Ray Lankester's "Secrets of Earth and Sea" (p. 141). Briefly, his view was that the serums of separated species are toxic to one another—as in the tables given by von Dungern and Hirschfeld and in this country by Back and Edwards, and thus prevent the fertilisation of the ovum of one species by the spermatozoon of another. "He proposed to inject one species by 'serums' extracted from the other, in such a way as seemed most likely to bring the chemical state of their reproductive elements into harmony, that is to say, into a condition in which they should not be actively antagonistic, but admit of fusion and union" (E. R. L.). I would suggest that the perplexing sterility of many normal, healthy young married couples is closely linked up with this question, and it may be that a great future is in store for the surgeon who would boldly adopt the suggestion of Milne-Edwards with the view of harmonising the serums of married persons whose relative sterility would appear to be capable of tabulation after the manner of the hæmolytic charts given by Back and Edwards and by the writer of the article in NATURE of December 2. CHRISTOPHER BLAYRE.

So far as I know, the blood groups dealt with in the article on "Human Blood Relationships" in NATURE of December 2 concern only the agglutination (and sometimes lysis) of red corpuscles and not any other of the obscure differences which determine incompatibility between species and subspecies. These no doubt include the qualities of tissues other than blood, and the project to alter them by transferring blood or serum from one species or individual to another seems very unlikely to succeed: the blood is only one tissue among many and its qualities certainly do not dominate those of the body as a whole. In the course of working out the inheritance of the agglutination groups a great deal of germane information has been obtained, but there is no indication that one combination of groups in parents is more likely to be sterile than another. The failure of many normal healthy young married couples to produce children is probably capable of a much simpler explanation.

THE WRITER OF THE ARTICLE.

Emission of Cathode and X-rays by Celestial Bodies.[1]

By Dr. HENRI DESLANDRES.

THE emission by the stars of X- and cathode rays and similar radiations has already been considered and investigated by various writers.[2] The two kinds of radiation, however—X- and cathodic—are not separable, for each, when it meets an obstacle, gives rise to the other, this interdependence having been clearly pointed out by de Broglie. But their properties are different: X-rays move in straight lines, and are much the more penetrating, while cathode rays are easily deflected into helical paths by a magnetic field—or, again, by an electric field. The paths of the electrified particles forming cathode rays, under the influence of a magnetic field like that of the earth, have been revealed by the detailed calculations of Störmer: they are very interesting, and much more varied than the trajectories due to gravitation.

I. In several notes, from 1896 to 1922,[3] I have suggested the emission of cathode and X-rays by the sun, and also by the nuclei of nebulæ. The rays of the solar corona can thus be explained, and also the aurora borealis and the magnetic disturbances of the earth, their connexion with sunspots, and even the lag of these disturbances behind the passage of a spot across the central meridian of the sun's disc—a lag due to the deviation imposed by the outer solar magnetic field. The same idea was put forward also in 1896 by Birkeland, who carried the investigation further: he was able to reproduce, in the laboratory, some of the phenomena of the aurora borealis by means of a small sphere placed in a vacuum, magnetised like the earth, and bombarded by cathode rays. Later, the researches, both theoretical and experimental, of Störmer made a great advance in the investigation, and placed almost completely beyond doubt the emission by the sun of ordinary cathode rays. In terms of these rays, Störmer explains the smallest details of the aurora borealis, so rich in singular phenomena. He has even been able to locate the origin of the rays in the sun, and to determine the value of the external solar magnetic field. This value, which is very small and equal to 10^{-7} gauss, is exactly that which I found in 1911 by another method depending on the radial velocities of the solar prominences recorded at Meudon.

The earth also emits these special radiations. The radio-active bodies in its solid crust and in its atmosphere emit α-, β-, and γ-rays, which ionise the atmospheric gases and explain partly the permanence of the terrestrial electric field. To explain the whole field, it must be assumed that there enter, from the outside, rays which are very penetrating—even more penetrating than any known X-rays. Further, if one ascends in the atmosphere—as did Kohlhörster, who reached a height of 9000 metres—the number of ions formed per second in a closed chamber is found to increase rapidly; at 9000 metres it is eight times as great as at the surface of the earth. The amount of this penetrating radiation therefore increases rapidly with altitude. It proceeds probably from the sun, directly or indirectly, or even from cosmic space,[4] but its exact origin has yet to be determined.

Such are the first results; they are extremely interesting, but still very incomplete. The investigation thus begun should be pursued with every means at our disposal.

II. Researches connected with the atmospheres of yellow stars, carried on at Meudon during 1922 with Burson, have led me to conclude that in these stars there is an extremely penetrating X-radiation, emitted by the interior strata or the nuclei of the stars. These results, which have been stated very briefly in former communications,[5] are now given in detail.

The sun, which is a yellow dwarf star, shows, as is known, in its integrated spectrum,[6] three groups of calcium lines—H_1, K_1; H_2, K_2; H_3, K_3—weak, but very distinct—which represent, respectively, the lower, middle, and upper strata of its gaseous atmosphere or chromosphere. Burson and I have discovered these lines—in particular, the lines H_2, K_2, H_3, K_3 in several *giant* stars which are equally yellow. They have the peculiarity that the lines, when compared with the neighbouring continuous spectrum, are stronger and wider than in the spectrum of the sun. The middle and upper strata of the chromosphere are more luminous and important than the corresponding solar strata.

Stars of the two types, giant and dwarf, have at the surface, however, the same chemical composition, the same temperature, and the same surface brightness. How is the difference in the luminosities of their atmospheres to be explained?

The atmospheric strata are represented by the radiations H and K, which, as is now known with certainty, are emitted by the ionised atom of calcium. If, therefore, we consider, in each type of star, a tube normal to the surface, having unit cross-section and extending from the surface to the outer limits of the atmosphere, the brightness of each stratum in the tube will be proportional, or at least closely related, to the number of ions formed in it per second. The number of ions formed must therefore be greater in the giant stars. Now one of the principal causes of ionisation already pointed out is the intense emission of electrons by the

[1] Translation of a paper read before the Paris Academy of Sciences on October 2, 1922.

[2] X-rays are constituted like the γ-rays of radium, except that the latter have a greater frequency. The ultra X-rays, discussed in this note, have a still greater frequency. In the same way, β-rays resemble cathode rays. As for α- (positive or anode) rays, which play an important part in ionisation in general, they are absorbed very quickly, and move only a short distance from their origin.

[3] *Comptes rendus*, 126, p. 1323, 1898; 134, pp. 1134 and 1486, 1902; 150, p. 65, 1910; 152, p. 1453, 1911; 155, p. 1573, 1912; 157, p. 517, 1913; 171, p. 451, 1920; 172, pp. 405 and 709, 1921; 175, p. 121, 1922. See also "Observations de l'Éclipse totale de 1893" (Gauthier-Villars, 1899).

[4] The earth also probably emits a very penetrating X-radiation—more penetrating than the γ-rays of radium: this has been suggested by some writers. But, if it exists, it is relatively weak, and it has not yet been clearly separated from the very penetrating X-radiation coming from external sources.

[5] Sur la reconnaissance dans les étoiles des couches successives de leur atmosphère et des variations périodiques de ces couches (*Comptes rendus*, 171, p. 451, 1920, by Deslandres). Recherches sur l'atmosphère des étoiles, Reconnaissance d'étoiles qui ont les mêmes brillantes de l'atmosphère que le soleil (*Comptes rendus*, 172, p. 405, 1921); Recherches sur l'atmosphère des étoiles, Reconnaissance de la couche supérieure dans quelques étoiles et comparaison avec le soleil (*Comptes rendus*, 172, p. 479, 1921); Recherches sur l'atmosphère des étoiles, Propriétés des étoiles qui ont les mêmes radiations et les mêmes couches de la chromosphère que le soleil (*Comptes rendus*, 175, p. 121, 1922, by Deslandres and Burson).

Burson and I intend to publish shortly some new results. In particular, we have discovered that, in certain giant stars, the lines H_3, K_3 of the upper stratum are displaced towards the red, and the lines H_2, K_2 of the middle stratum are displaced towards the violet, as in the case of the sun.

[6] The integrated spectrum is that which the sun would give if it were as far from us as the stars.

surface, produced, in the yellow stars, at a temperature of about 6000° C.; but the ionisation from this cause is the same in the two types of star. In order to explain the greater brightness of the giant stars, it is necessary to suppose that they contain another source of ionisation which is peculiar to them, or more important than it is in the dwarf stars. The principal supplementary cause appears to me to be a penetrating radiation emitted by the interior layers of the star; this radiation would be stronger in giant stars, which have greater masses, and therefore higher internal temperatures. In an example cited by Eddington[7] the temperature at the centre reaches 4,650,000° C., the mass being only one and a half times that of the sun. The wave-length of maximum energy for a black body at this temperature is 6 Å.U.—corresponding to an X-ray near the ultra-violet, and not very penetrating; but, according to the theory, the radiation extends much further towards the very short wave-lengths, the penetration of which is much greater; and the intensity of these extreme radiations increases with the temperature of the star. The emission of exceptionally penetrating radiations by giant stars is therefore admissible. Further, in the case of giant stars which are in the phase of increasing temperature, the atoms are dissociated, and their breaking-up is accompanied by an intense emission of α-, β-, and γ-rays. It should be remarked that recently certain rays of radium have been observed, much more penetrating than any previously known, the source of which must be in the very nucleus of the atom.

In the yellow stars, all these radiations, of very high frequency and of great penetrating power, form, in reality, only a very small part of the total radiation; but their remarkable electrical properties assign to them an important rôle in the electrical phenomena of stellar atmospheres. It is not, however, intended to assert that the existence of the radiations is proved, but it is very probable. As a matter of fact, we have a very imperfect knowledge of the properties of the material in the interior of a star near the surface and in the atmosphere; and, as often happens in astronomy, the deductions rest on wide extrapolations. In forming conclusions, great care must be exercised.

There has been a great deal of discussion on the nature of the solar surface. In my opinion, setting aside every theory and every explanation, the solar surface is a simple fact of experience; it is a surface of discontinuity, with a clear-cut boundary, such that the light emitted by the interior is much more intense than that given by the exterior. I give the name "atmosphere" to all that is outside this surface. The word "surface," however, should not be understood strictly in its geometrical sense: it implies, actually, a relatively thin luminous stratum which, at our distance from it, appears to have no thickness. The solar surface has often been described as a cloud, made up of incandescent liquid or solid particles. If this were so, in all the yellow stars having the same temperature, whether giant or dwarf, the pressure of the gases at the surface should be the same; but it has been objected that we have no knowledge of any matter which remains liquid at a temperature of 6000° C. The attractive optical theory of Schmidt also has been advocated: when thoroughly examined, however, it is found not to be applicable to the sun. Let us say simply that, from a cause still imperfectly understood, solar matter, probably gaseous, acquires suddenly, in a stratum called the *surface*, the emissive power of a solid body, and there are good reasons for believing that the pressure of the gas in this stratum varies little from one yellow star to another, so long as the temperature of the strata is the same.[8] These considerations support the idea of the very penetrating emission postulated in the giant stars.

III. These special rays, remarkable for their penetration and their electrical action, have been known or suspected only for a few years; but their importance is already declaring itself, and I think that they will furnish the key to several of the still numerous enigmas presented by the celestial bodies.

The matter of the sun, then, probably emits X-, ultra-X-, and corpuscular rays, with an intensity which increases from the surface to the centre. In the spots, which are in general cavities, the emission is strongest in the centre, and, because of its greater penetration, is able to persist in spite of local absorption and the diminution of the ordinary light. Similarly, if the earth gives rise to a radiation of this kind, its intensity should be greater at the poles than at the equator.

These radiations should be borne in mind especially in considering the nebulæ—in particular, the gaseous and planetary nebulæ. A nebula with a stellar nucleus may be considered as a star the atmosphere of which is extraordinarily developed and contains special gases, such as nebulium. The conditions are then, on a very large scale, those of the yellow giant stars examined above, the atmospheres of which are particularly bright; and the same causes may be held to account for the luminosity in the nebulous atmosphere. Moreover, the nucleus, being of the Wolf-Rayet type, is one of the hottest stars: it is conceivable that the maximum emission takes place, for the nucleus in the X-region, and for the nebula, properly so called, in the visible region. The luminosity is produced by radiations of very short wave-length, but with a habitual tendency towards longer wave-lengths. Lastly, the nucleus may contain a large proportion of radio-active bodies. These ideas were put forward in 1902, and Russell has recently developed similar hypotheses.[9]

If a nebula has no nucleus, we may suppose that there are radio-active bodies disseminated in the space which it occupies. Similarly, in the lower part of our atmosphere, a considerable fraction of the ions formed per second is due to the gaseous emanations of radium and rhodium spread abroad in the air. If there were a greater proportion of radio-active bodies, the gas might become luminous.

To sum up, the penetrating radiations are interesting in the highest degree, and it is important that we

[7] *Astrophysical Journal*, 48, pp. 205-214, 1918.

[8] If the pressure at the surface is less in the giant stars, the average density of which is smaller, we can explain partly the stronger ionisation in these stars by the very interesting theory of M. N. Saha. This theory deals with effects due to temperature alone, and the point of view is different. In a giant star the pressure gradient is evidently less steep, but the average pressure in the middle stratum, and especially in the upper stratum, may be very nearly the same as in a dwarf star. It should be noted that the greater proportion of the positive ions of calcium in the upper atmosphere may also be explained simply by the repulsion due to the positive charge on the star.

[9] Deslandres, *Comptes rendus*, 134, pp. 1134 and 1486, 1902; Russell, Proceedings of the U.S. National Academy of Sciences, 5, No. 10, p. 410.

should study, immediately and as thoroughly as possible, those which are within our reach and are disclosed by Kohlhörster's experiment. The ionisation of gases in a sealed vessel has been measured in our atmosphere up to an altitude of 9000 metres; but it is necessary to repeat the experiment at several places on the earth, and to extend it up to the greatest altitudes reached in exploring balloons. The undertaking, it is true, will be costly; it devolves especially on the countries which have the greatest resources. I proposed, at the International Astronomical Congress, which met at Rome in May last, that there should be international co-operation for the complete study of the electrical phenomena of our atmosphere at great altitudes. The determination of the exact origin of these penetrating radiations is one of the most important problems confronting physical astronomy at the present time.

The Desensitising of Silver Bromide-Gelatin Plates.

By Dr. T. SLATER PRICE.

IT is well known that the more sensitive a photographic plate is, the greater the care that has to be taken with respect to the actinic value of the light used in the dark room during the operation of development. The less the amount of light used, the more difficult it becomes to control the result; and it is therefore not to be wondered at that attempts have been made to modify the course of procedure in such a way that the exposed plate could be developed in a fairly good light. During the last few years various so-called "desensitisers" have been put on the market; when the exposed plate is either treated with a solution of these before development, or when some of the desensitiser is added to the developer, the plate can safely be developed in a light which would otherwise give rise to very bad fogging.

At the recent Deuxième Congres de la Chimie Industrielle, M. A. Seyewetz gave an interesting account of the subject, and his paper has been published in *Chimie et Industrie*, 1922, 8, 308-311.

A. and L. Lumière and Seyewetz, in 1907, were the first to notice that a silver bromide-gelatin plate becomes less sensitive when bathed in a solution of a developer such as diaminophenol, quinol, or pyrogallol. The loss in sensitivity varied slightly in different regions of the spectrum, but was most marked in the yellow and green. At a much later date, in 1920, Lüppo-Cramer noticed that the desensitising action was much increased when sulphite was omitted from the developing solution, that is, when the developer was used in such a condition that it readily oxidised in the air. After immersion for a minute in a 0·05 per cent. solution of the developer the plate could be developed in yellow light without fogging. Such a method of desensitisation was insufficient, however, for orthochromatic and panchromatic plates, and moreover, the solutions underwent rapid alteration in the absence of sulphite.

Desensitisation only became a practical proposition when Lüppo-Cramer, in 1921, discovered the pronounced desensitising action of the azine dye, Phenosafranine, and also of other dyes belonging to the same class, on ordinary and panchromatic plates. Contrary to what one would at first suppose to be the case, these dyes do not owe their action to functioning as colour screens; solutions of Phenosafranine transmit red and violet light, and yet they desensitise plates for these regions of the spectrum. Also, the violet safranines desensitise just as do the red safranines, although their absorption spectra are very different. These facts are very similar to those observed with sensitisers, and Lüppo-Cramer has shown that certain optical sensitisers for one haloid salt of silver may act as desensitisers for other salts. For example, Erythrosin, Rhodamine B, Pinachrome, and Pinacyanol, which are the best sensitisers for chloride and bromide of silver, when used in very dilute solutions (1 : 20000) diminish the sensitivity of silver iodide-gelatin plates from 6 to 16 times; Phenosafranine gives a reduction in sensitivity of about 40 times.

Lumière and Seyewetz have made investigations to see if there is any relation between the desensitising power of a substance and its chemical constitution. They have found, with the safranines, that the presence of the characteristic phenazine grouping,

$$C_6H_4 \langle {N \atop N} \rangle C_6H_4,$$

is insufficient in itself, and that amino-groups substituted in the benzene nuclei must also be present. Thus Neutral Red, which is a Eurhoidine having the formula

$$NMe_2 . C_6H_3 \langle {N(HCl) \atop N=\!=\!=} \rangle C_6H_2Me . NH_2,$$

has desensitising properties approximating to those of Phenosafranine, which is

$$NH_2 . C_6H_3 \langle {N(C_6H_5Cl) \atop N=\!=\!=} \rangle C_6H_3 . NH_2.$$

Safranines in which one of the amino-groups has been eliminated, as in aposafranine, or in which this group is replaced by oxygen, as in the safranones, are notably less active as desensitisers. If both of the amino-groups are replaced by O or OH, as in safranol, there is no longer any desensitising action. The acetylation of the amino-group, or its diazotisation and copulation with a phenol, destroys the desensitising properties of the safranine, while the replacement by ethyl of the phenyl group attached to the nitrogen has no effect. The Indulines, which are near cousins to the safranines, as also the thiazines and the oxazines, do not act as desensitisers. On the other hand, other colouring matters which have very different constitutions from that of safranine as, for example, picric acid, Indian Yellow, Chrysoidine, etc., are weak desensitisers; Aurantia (1 : 1000) desensitises as actively as safranine for the blue rays, but is noticeably less active towards other parts of the spectrum.

It follows from the above that there does not seem

to be a definite relation between the constitution of the dye and its desensitising properties. The conditions are thus very similar to those which hold in the case of sensitisers.

The great drawback to the use of Phenosafranine is its pronounced staining properties; it can only be removed from the gelatin film by prolonged washing. König has recently put on the market a desensitiser, Pinakryptol, which is claimed to be as active as Phenosafranine, but which neither stains gelatin, celluloid, nor the skin, although it gives a deep green solution.

A satisfactory explanation of the desensitising action of these substances is still wanting. Lüppo-Cramer claims that the phenomenon is connected with the formation of an oxidation product of the dye. Lumière and Seyewetz have shown, however, that if an unexposed plate is bathed in a solution of Phenosafranine it recovers its original sensitivity after being washed sufficiently long to remove the colouring matter. It is probable, according to Lumière and Seyewetz, that any oxidation product of the dye would be adsorbed by the silver bromide and not be removed by washing, so that the recovery in sensitivity would not be explicable on Lüppo-Cramer's theory.

Obituary.

Prof. Georges Lemoine.

M. GEORGES LEMOINE, professor of chemistry at the Polytechnic School, Paris, whose death at the age of eighty-one has just been announced, was born at Tonnere in 1841. He entered the Polytechnic School in 1858, and two years later became *Elève ingénieur* at the École des Ponts-et-Chaussées. He early devoted himself to the study of chemistry, and investigated the compounds of sulphur and phosphorus, one of which, the sesquisulphide of phosphorus, is now largely employed in the igniting composition of the lucifer match in place of ordinary phosphorus. The substitution of this compound for phosphorus—now compulsory in most countries where matches are made—has been attended with the most beneficial results in the industry, the "phossy jaw" of the match-worker, or necrosis of the facial bones, being practically a thing of the past.

Lemoine also studied the reciprocal transformation of the two best-known allotropes of phosphorus. By heating known weights of phosphorus in closed flasks at 440°, the temperature of boiling sulphur, for varying lengths of time, and separating the products by carbon disulphide, he was able to determine the influence of time and pressure on the direction and extent of the change. He showed that the extent of the transformation is determined by the tension of the vapour, as in the case of other phenomena of volatilisation and dissociation. *In vacuo*, the conversion of ordinary into red phosphorus becomes more and more rapid as the temperature is raised. The rapidity of the transformation varies with the amount of phosphorus used. At any given moment the rapidity depends not only upon the quantity of ordinary phosphorus remaining, but also upon the quantity of red phosphorus already formed. The phenomenon is pre-eminently one of vapour tension and depends upon the capacity of the vessel in which the transformation—which is never complete—is effected. These facts are now well known and are uniformly acted upon in the phosphorus industry.

Questions of chemical dynamics had always a certain measure of attraction for Lemoine, and although he was not a particularly prolific contributor to chemical literature, much of his published work is concerned with their investigation. One of the most important of these inquiries relates to the conditions of chemical equilibrium of hydriodic acid. This substance was chosen as suitable for the study of the general phenomena of chemical equilibrium for the reason that the constituent elements are monatomic; they combine, or dissociate, without change of volume (at the temperature of the experiment), and the thermal effects of combination are very slight. The aim of the investigation was to show that under given conditions of temperature and pressure, a mixture of the two constituent gases in given proportions will attain sooner or later a definite state of chemical equilibrium in which only a certain proportion of the hydriodic acid possible is actually formed, varying with the temperature, pressure, and proportions of the gases present, but always the same for the same conditions. The conditions studied were heat, pressure, mass, the action of porous bodies, of oxygen and of light. The main results have long since been incorporated into the general theory of chemical change, and call for no detailed account. At the time of their publication they constituted a notable and novel contribution to chemical dynamics.

It has long been known that mixed solutions of ferric chloride and oxalic acid are decomposed by light with the evolution of carbonic acid (Marchand, Jodin), and that the rate of decomposition depends on the intensity of the light. Lemoine studied this change with a view of determining how far it may be made the basis of an actinometric method. He found that for a given intensity, the evolution of gas is at first uniform, but that when about half the total quantity of carbon dioxide has been evolved, the rate of decomposition gradually diminishes. The greater the volume of the liquid, the longer is the time before decomposition slackens. When the two solutions are separately exposed to light for several hours and then mixed, decomposition takes place more rapidly than if the solutions had not been previously insolated. Dilution with water increases the change, due probably to hydrolysis of the ferric chloride. At ordinary temperatures the mixed solutions are practically unaffected in the dark. On heating, gas begins to be evolved at 50° and increases rapidly in amount as the temperature rises. The general course of the change is, however, very similar to the influence exercised by light and is affected apparently by the same conditions.

Lemoine occasionally worked at subjects of organic chemistry, such as the nature of the paraffin hydrocarbons and the dissociation of haloid compounds of olefines under the influence of heat and pressure, but organic chemistry had evidently few attractions for him, and his work in this special field was very limited and calls for no special comment.

Lemoine, having served the Polytechnic School, in various capacities, from 1871, was elected professor in 1897. He succeeded Friedel as a member of the chemistry section of the Academy of Sciences in 1899.

T. E. THORPE.

HOWARD FOX.

MR. HOWARD FOX, of Falmouth, died on November 15, in his eighty-sixth year. In the intervals of a busy commercial and consular career—the firm to which he belonged were appointed American Consuls by George Washington—he contributed very largely to our knowledge of the natural history of his native county, Cornwall, especially in the domain of geology. The record of his work is to be found in many papers published by the Royal Geological Society of Cornwall, of which he was president during the years 1893 and 1894, the Geological Society of London, the *Geological Magazine*, and other scientific institutions and journals. We can only refer to a few of his more important discoveries.

Mr. Fox traced the distribution of the Radiolarian (Codden Hill) Beds of the Lower Culm Series throughout the west of England; and, in collaboration with the late Dr. G. J. Hinde, studied the characters of these rocks and of their radiolaria. He also discovered the radiolarian cherts of Mullion Island, which belong to a much lower geological horizon. Among other fossils found by him is the notable *Pteroconus mirus*, probably allied to the pteropods, occurring in the supposed Lower Devonian rocks of Bedruthan Steps, north of Newquay, the younger stages of which are sometimes preserved in such a way as closely to resemble graptolites. He also published accounts of other Cornish fossils, relying on the help of specialists for their determination and description.

But Mr. Fox's interest was by no means confined to the fossiliferous rocks. He studied the igneous and metamorphic rocks of the Lizard peninsula and made himself familiar with every nook and corner of that rock-bound coast. By mapping a small portion of the sloping face of a cliff, on a scale much larger than that of any published map, he proved conclusively that the serpentine and hornblende-schist had been intimately interfolded; and, by observations on another portion of the coast, established the fact that certain rocks, apparently belonging to the "Granulitic Series," were intrusive in the surrounding schists. He also made the important discovery that the Man of War rocks, off Lizard Head, are mainly formed of a corrugated igneous gneiss, quite different from any rock occurring on the mainland.

In petrology and mineralogy, as in palæontology, Mr. Fox availed himself of the help of specialists, and all those who were thus brought into personal contact with him were captivated by his geniality and stimulated by his enthusiasm.

LORD SUDELEY, F.R.S.

CHARLES DOUGLAS RICHARD HANBURY-TRACY, fourth Baron Sudeley, whose death on December 9, in his eighty-third year, will be regretted in many circles, was elected a fellow of the Royal Society in 1888, in recognition of his services to science as chairman of the British Commission to the Electrical Exhibition at Vienna in 1883. Of late years, Lord Sudeley persistently advocated in the House of Lords and in the Press the increased use of our museums and picture-galleries for the education and recreation (in the highest sense) of the public. In 1910, struck by the value of a demonstrator engaged by the Science Committee at the Japano-British Exhibition, he urged that similar guide-lecturers should be attached to our national museums. The Natural History Museum was the first to adopt the suggestion, and now, thanks to Lord Sudeley's untiring efforts, all the larger public museums have one or more of these popular adjuncts. Next he actively promoted the production and sale of picture postcards by Government museums. Lastly, as shown by his article in the *Nineteenth Century* for October, he was preparing to move for the appointment of a Royal Commission to consider the better working of the museums of this country.

MR. HERBERT WOODVILLE MILLER, who died on December 4, was one of the pioneers of electric lighting in this country. In 1886 he was appointed to assist Crompton and Co. in working out the system of electric light distribution in the West End of London which they had successfully installed in Vienna. By 1899 it was evident that stations centrally situated in populous districts were unsuitable to meet a growing demand, and Miller therefore designed and carried out the power station at Wood-lane which supplies the Kensington and Knightsbridge Company and the Notting Hill Co. He was engineer and manager of the Kensington Co.; the station beneath the Albert Hall is an excellent example of an accumulator station. He served on several committees of the International Electrotechnical Commission, and his thorough knowledge of electrotechnical subjects made him a most useful member of the editing committee of the British Engineering Standards Association.

THE *Chemiker Zeitung* of November 23 announces the death on November 20 of Prof. August Horstmann, at the age of eighty. Prof. Horstmann was the first to show the applicability of the laws of thermodynamics to chemical problems, his first paper on this subject being published in the *Berichte* in 1869. His other work was mainly in this direction, and was concerned with problems of dissociation, the determination of vapour densities and vapour pressures, specific heats, and heats of reaction. He was therefore the pioneer in a branch of physical chemistry which has since been developed particularly by Van't Hoff and Nernst. For some years Horstmann was professor emeritus of theoretical chemistry in the University of Heidelberg.

WE learn from *Science* with much regret of the death, on November 1, of Dr. R. W. Willson, emeritus professor of astronomy at Harvard University, at the age of sixty-nine years.

Current Topics and Events.

BROADCASTING has now been carried on for some time at the Trafford Park works of the Metropolitan-Vickers Electrical Co., Ltd., on behalf of the British Broadcasting Company, and on December 15, representatives of the Press were invited to inspect the equipment of the station and to listen to a short, typical broadcasting programme. The present arrangements are of a somewhat temporary nature, made with the view of gaining experience, and it is expected in course of time to improve both the technique of transmission and reception, and the quality of the programmes. In a short address, Mr. A. P. M. Fleming expressed his view that wireless telephony has an important future as an educational and social feature of daily life, and he hoped that the public would not take the present transmissions as the best the Broadcasting Company expected to be able to give them. Research is being carried on actively to improve the faithfulness of reproduction of music and speech. It has been found necessary to select carefully the kind of voice which is best suited to the vagaries of the microphone, and it was foreshadowed that a special wireless studio technique will have to be developed, for which special training of the performers will be required. There is no doubt that the transmission of some items leaves much to be desired, but if a microphone or a substitute for it could be developed, having no prejudice for any particular sound, a considerable improvement would be effected. The simplest sounds, such as in solo pieces, give the best results, and it would seem that when a number of voices or instruments are operating simultaneously, the microphone is not able to deal faithfully with the various sounds.

THE annual exhibition of scientific apparatus organised by the Physical Society of London and the Optical Society will be held on Wednesday and Thursday, January 3 and 4, from 3 to 6 P.M. and from 7 to 10 P.M., at the Imperial College of Science, South Kensington. Mr. W. Gamble will lecture on "Reproduction of Colour by Photographic Processes" at 4 P.M. on January 3 and at 8 P.M. on January 4; Prof. E. G. Coker will lecture on "Recent Photo-Elastic Researches on Engineering Problems" at 8 P.M. on January 3 and at 4 P.M. on January 4. All the lectures will be illustrated by experiments. More than fifty firms are exhibiting apparatus and a number of experimental demonstrations have been arranged. Invitations to attend the exhibition have been given to the Institution of Electrical Engineers, the Institution of Mechanical Engineers, the Chemical Society, the Faraday Society, the Wireless Society of London, and the Röntgen Society. Members of these societies should apply to the secretary of the society to which they belong for admission tickets. Others interested should apply direct to Mr. F. E. Smith, hon. secretary of the Physical Society, Admiralty Research Laboratory, Teddington, Middlesex.

A JOURNEY of more than seven thousand miles from Peking to India was completed early in December when General Sir George Pereira arrived at Calcutta. The *Times* gives some details of his route. Leaving Peking nearly two years ago, Sir G. Pereira went by rail to Taiyuen. From there he made for Hoyang, crossing the Hoang-ho, and reached Sianfu, the ancient Chinese capital in the Wei valley. The route was thence across the Tsinling mountains to Chengtu, in the Szechwan basin, and up the valley of the Min into the Kansu province. Passing through Siningfu and Tenkar, Sir G. Pereira entered Tibet on a little known route. The track lay at an altitude of about 12,000 ft. through an arid country in which supplies were scanty and the weather conditions somewhat trying. The Yangtsè was crossed at Giergundo and eventually Lhasa was reached in October. From Lhasa to Darjeeling a fairly well known route was followed. One of the most interesting facts mentioned in the *Times* article relates to the so-called Amnemachin range in the bend of the Hoang river in north-eastern Tibet. This is a solitary snow-capped mountain and not a range. Its height has not been measured, but Sir G. Pereira suggests that it may prove to be the highest mountain in the world. About half the entire journey was done on foot, and even in the most brigand-infested regions the travellers were never attacked.

THE Munro lectures in anthropology and prehistoric archæology for 1922 in the University of Edinburgh have been delivered in November and December by Prof. R. A. S. Macalister, of University College, Dublin, on the subject of "Rock Carvings and Inscribed Symbols of the Neolithic and Bronze Ages." Starting with certain Spanish stones presenting linear devices that could be proved to be degenerate copies of the human figure and other concrete objects, Prof. Macalister developed the thesis that an explanation of this kind would account for the enigmatical devices, such as concentric rings, found so often in Great Britain and Ireland on exposed rock faces, standing stones, and slabs built into dolmens and chambered cairns. British monuments were brought into relation with similar objects in wider archæological areas; by the extended use of the comparative method, much light has been thrown on symbols and devices the meanings of which have been the subject of much vague conjecture. The female figure carved in some French neolithic tomb chambers is a goddess of death, and representations of her, which might degenerate till only two eyes or even a single one remained, can be recognised on stones forming part of funereal structures in our own islands. Such structures, as Irish folk-lore bears witness, were visited for superstitious purposes by the living, and the cup marks common on the stones forming them were intended for real or simulated libations offered to the spirits of the place. Such cup marks on exposed rock faces in the open might be explained on the hypothesis that religious sanctuaries of perishable materials had once existed in their vicinity. The same system of interpretation was applied to other marks and devices of a similar kind.

THE application of eugenic principles to the improvement of the human race is discussed by Dr. J. G. Adami in an address before the International Eugenics Congress in New York, published in the *Eugenics Review* for October 1922. Dr. Adami points out that eugenic measures hitherto suggested or adopted have been chiefly negative in character, aiming at preventing a progressive increase in the number of defectives in the population. He advocates an important measure of practical positive eugenic value, which the Eugenics Education Society would do well to consider seriously. Dr. Adami's suggestion arises out of his experience as a member of the scientific committee of the Advisory Council of the Ministry of National Service during the war—a committee which analysed the physical state of the manhood of Britain during the last year of the war, examining the records of nearly two and a half million men. That a high percentage in many industrial areas were found to be physically unfit is well known. The eminent services of American psychologists in applying intelligence tests successfully to American recruits are now also widely recognised. Dr. Adami's suggestion is based upon these two results. It is, that eugenists organise centres throughout the country where young persons of eighteen could be given voluntary tests of physical fitness and intelligence, the lists of those who attain standard A being published. In this way a true aristocracy of mental and physical fitness would arise which would be of the utmost value to the nation.

IN the second of his Chadwick public lectures on "Relative Values in Public Health," delivered on December 14, Sir Arthur Newsholme referred to the relative weight of mortality of different diseases in relation to their degree of preventibility. He stated that tuberculosis caused ten deaths for every three due to the acute notifiable diseases. Tuberculosis is a too little recognised cause of death in childhood, and its prevention is an essential part of child welfare work, the foundation of all public health work. The amount spent on public health in large English and American towns averages about 5*s.* *per capita* per annum, or in England, from 4 to 8 per cent. of the total rates collected *per capita.* Sir Arthur Newsholme is of opinion that the greatest and quickest return in health for money expended—outside the ordinary sanitation of a city—is in respect of work on maternity and child welfare, and on the prevention and treatment of tuberculosis and venereal diseases.

A CONFERENCE on Industrial Fuel will be held next spring in Paris under the patronage of M. Le Trocquer, Minister of Public Works, and with the support of the Société d'Encouragement pour l'Industrie Nationale. The proposed agenda include discussions on the assay of various fuels, rules for testing boilers, producers, and furnaces, standard methods of making measurements required in controlling the use of fuel, construction of furnaces, use of pulverised fuel and of low-grade fuels. Any communications concerning the conference should be addressed to the Président de la Commission d'Utilisation du Combustible, Ministère des Travaux Publics, 246 boulevard Saint-Germain, Paris. Notices and reports concerning the conference will be published in *Chaleur et Industrie.*

ACCORDING to a statement in the *Meteorological Magazine* for November, daily weather charts of the Northern Hemisphere are now being prepared by the Meteorological Office each day. The charts are exhibited in a ground-floor window in the Air Ministry, Kingsway, and show barometric pressure and wind for an area covering roughly the temperate zone from the Pacific coast of America in the west to the western borders of Asia in the east. In an adjoining position, at the Air Ministry, a large blackboard map of weather conditions in north-west Europe is shown. These maps giving the existing weather conditions over such a large area of the earth's surface will doubtless aid in the improvement of weather forecasting.

No. 24 of the Reprint and Circular Series of the National Research Council, Washington, which has been received, is a pamphlet by C. J. West and H. Gilman dealing with "Organomagnesium Compounds in Synthetic Chemistry." It contains a bibliography of 1485 papers, as well as an exhaustive index. Monographs of this type are very useful to investigators, and the National Research Council in America is doing valuable work in arranging for their publication. The Research Information Service of the Council is prepared to supply information about scientific methods and results, and their applications in engineering, industry, and education. No charge is made for replies to inquiries which do not necessitate a special search for information (there are extensive files already assembled); those requests for data which would necessitate the expenditure of a considerable time for accumulation are acknowledged, with an estimate of the cost. The Service has a staff of specialists, and is in touch with current scientific work of all kinds. It is clear that such an organisation must be of very great service to investigators in the United States, and the Scientific and Industrial Research Department in this country might consider the formation of a similar organisation in this country.

THE Mann Juvenile Lectures of the Royal Society of Arts will be delivered on Wednesdays, January 3 and 10, by Mr. C. R. Darling, who will take as his subject "The Spectrum, its Colours, Lines, and Invisible Parts, and some of its Industrial Applications." Admission is by ticket only.

THE Dorset Field Club is offering the Cecil medal and prize of 10*l.* for the best paper on "Recent Advances in Chemistry as applied to Agriculture, with special reference to Dorset Conditions." The competition is open to persons aged between 17 and 35, either born in Dorset, or resident in that county for one year between May 1, 1921 and 1923. Further particulars may be obtained from Mr. H. Pouncy, Midland Bank Chambers, Dorchester.

DR. R. A. HOUSTOUN, of the University of Glasgow, has in the press, for publication by Messrs. Longmans

and Co., "Light and Colour," a book intended for the general public, and dealing in a popular way with the discovery of the spectrum, the nature of light, the Einstein deflection of light, the quantum, invisible rays, spectroscopy and the constitution of the atom, the primary colours, colour blindness, colour photography, artificial illumination, photochemistry, phototherapy, and the psychology of colour. Another book in the same publishers' announcement list is "Gas Manufacture," by Dr. W. B. Davidson, in which the subjects of gas engineering and gas supply are fully dealt with from the chemical standpoint. The book aims at meeting the demand of the gas engineer for a more intimate acquaintance with the chemistry and physical chemistry of gases than he may already possess, and is intended as a textbook for the young student of gas engineering.

THE first part of Messrs. Wheldon and Wesley's illustrated catalogue of recent purchases of rare books now offered for sale, which is issued this month, is remarkable for the number of rare and interesting books on herbal and garden literature which it contains. There are also books on early medicine, birds, shells, and other subjects, which are, in many cases, fully illustrated. The transcription of the titles has been very carefully done and the bibliographic details will be of value to lovers of books. The collection contains a first edition of Peregrinus "De Magnete" published in 1558 and also the first English edition of Harvey's account of his discovery of the circulation of the blood, with the title "Anatomical exercises concerning the motion of the heart and blood." In addition, the collection contains first editions of Jenner's accounts of his discovery of vaccination, in regard to which it is said that he was advised not to publish them in the Philosophical Transactions lest they should injure his reputation as author of a paper, already published therein, on the cuckoo.

Our Astronomical Column.

RELATIVITY AND SPACE.—The *Irish Ecclesiastical Record* of November 22 contains an article on the subject by Rev. H. V. Gill, S.J. It is intended for general readers, and opens with an explanation of the reasons for the introduction of time as a fourth dimension. From this the author goes on to consider the nature of space, and comments on the difficulty of conceiving that a mere vacuum can be modified by adjacent matter, and also how matter could exert its influence over remote matter across a vacuum without involving "action at a distance" which Einstein rejects. He then quotes Einstein's "Sidelights on Relativity," an English translation of two lectures delivered in 1920 and 1921. Many of Einstein's followers in England have been inclined to abandon the conception of the æther, but he himself states "according to the general theory of relativity, space is endowed with physical qualities; in this sense, therefore, there exists an ether . . . space without ether is unthinkable . . . there would be no propagation of light. . . . But it may not be thought of as . . . consisting of parts which may be tracked through time." It is useful to direct attention to this clear statement of Einstein's view, and it would help matters if those who reject the æther conception were to indicate how they surmount the difficulties that are pointed out.

THE MASS AND PROPER MOTION OF 40 ERIDANI.—This interesting triple system was discovered by Sir W. Herschel in 1783. A is of magnitude 4·5, B 9·4, C 10·8. The distance AB is 83″ and BC is 3″. All three have the great proper motion of 4″ per annum in position-angle 213°. Prof. G. Abetti makes a study of the system in vol. 30 of the Proceedings of the Academia dei Lincei. He adopts the parallax 0″·219, which makes the absolute magnitudes 6·2, 11·1, 12·5. Using Doolittle's elements, which give a period 180 years to BC, the masses in terms of the Sun are found to be B = 0·20, C = 0·12. C is the least massive star yet measured; this position was previously held by the companion of Krüger 60, mass 0·19. B is a very anomalous star, since it appears to be of spectral type A in spite of its small luminosity; recent photographs at the Lick Observatory indicate that C is of type M*d*, with the H_β line bright.

The velocity of the system at right angles to the line of sight is 88 km./sec.

It is of interest to compare this system with σ Coronæ, also investigated by Prof. Abetti. The combined mass is here 5·57 times that of the Sun. The evidence as to relative masses is contradictory; he provisionally assigns equal masses, and deduces for the densities 0·34 and 0·99 in terms of the Sun. The spectral types of both are F9.

DISTRIBUTION OF STARS OF SAME SPECTRAL CLASS.—The study of the distribution of stars of similar spectra is very important, especially if it leads to some definite law regarding their grouping with regard to the Galaxy. The special case of the B-type stars is discussed in a recent circular (No. 239) of the Harvard College Observatory, by Dr. H. Shapley and Miss A. J. Cannon. It was thought at first that very few B-type stars, fainter than the seventh magnitude, existed, and that these formed quite a local system. The authors find that, while the former does not now hold good, the bright B stars do indicate the existence of a local star cloud. The results of the discussion are plotted in four figures showing the galactic distribution of the stars, the figures being confined to stars brighter than 5·26 magnitude, stars between magnitudes 5·26 and 6·25, between magnitudes 6·26 and 7·25, and finally between magnitudes 7·25 and 8·25. The result of the investigation clearly shows that the fainter the B stars are the more they are situated along the galactic equator. Quite a considerable number of stars are used for each figure, namely 346, 367, 564, and 719. Forming median galactic latitudes for each thirty degrees of longitude the highest values in each figure are −15°·5, −15°·0, −11°·5, and −3°·5. More than 90 per cent. of the fainter B stars are within ten degrees of the galactic equator. A table is given showing all known B stars to the apparent magnitude 8·25 which are in higher galactic latitude than 50°.

Research Items.

MAMMALS AND BIRDS FROM HAITIAN CAVES.—A small collection of bones of mammals and birds were obtained in 1921 by Mr. J. S. Brown and Mr. W. S. Burbank during geological studies under the U.S. Geological Survey for the Republic of Haiti, from two caves situated between 3 and 4 kilometres N.E. of St. Michel and 600 metres above sea-level. These bones have now been described respectively by Mr. G. S. Miller, junr., and Mr. A. Wetmore (Smithsonian Miscell. Coll. vol. lxxiv. Nos. 3 and 4). Rodents were the more plentiful among the mammals, the most abundant being *Isolobodon portoricensis*, Allen, which also occurs in Porto Rico and the Virgin Islands. Two new genera are established: Alphætreus, with *A. montanus*, n.sp., as genotype, which is allied to Plagiodontia and Isolobodon; and Ithydontia, genotype *I. levir*, n.sp., allied to Isolobodon. *Brotomys voratus*, Miller, was also present as well as a ground sloth, doubtfully referred to the genus Megalocuus, and a few unidentified mammals, while man was represented by the head of a femur and an implement made of chert. Early man, however, though known to have used these rodents as food, does not appear in this case to have been responsible for the presence of their remains in the caves. Their importation would seem to be due to a huge extinct barn owl, which Mr. Wetmore names *Tyto ostologa*, n.sp. Possibly the *Chæmepelia passerina, Crotophaga ani*, and *Tolmachus gabbii*, also present in the caves, were further victims of the owl.

AN INDIAN POND-SNAIL.—Dr. N. Annandale and Maj. R. B. Seymour Sewell have published (Rec. Ind. Mus. xxii. pp. 215-292) a memoir on the banded pond-snail of India (*Vivipara bengalensis*). The latter author contributes an account of the anatomy and bionomics; Dr. Annandale deals with the systematic features and with the histology of the edge of the mantle and the external ornamentation of the shell. Spiral rows of horny chætæ and fine spiral ridges on the periostracum are present, and, indeed, best developed in the fully formed embryo, and disappear, as a rule, in the full-grown shell. In those shells ornamented with bands of dark pigment, the latter are periostracal in origin and, with the test sculpture, correspond in position with the rows of chætæ and the spiral ridges. The free edge of the mantle bears at least three digitiform processes,—other secondary ones may be present,—and the processes correspond in position with and are concerned in moulding the periostracal sculpture, the colour pattern and the sculpture of the test. In the systematic account eleven races of the species are recognised. The parasites and incolæ met with are recorded and include spirochætes and ciliates in the alimentary canal, rarely sporocysts and developing cercariæ, but frequently encysted cercariæ of two species.

MEADOW GRASSES.—In an article on the comparative morphology and development of *Poa pratensis, Phleum pratense and Setaria italica*, in the *Japanese Journal of Botany*, vol. i. No. 2, pp. 53-85 (1922), Makoto Nishimura has devoted special attention to the phenomena attending the germination of these grasses in comparison with *Agrostis alba*. In *Poa pratensis* the percentage of germination was lowest, 50 per cent., and the process extended over the longest time, while in Setaria 95 per cent. of the seeds were viable, and started into growth very rapidly. Absorbing hairs were developed on the coleorhiza at an early stage, and continued functioning until long after the elongation of the roots; similar hairs were also produced from the epiblast. The various stages of development during the first two seasons of growth have been followed out, being characteristic in each case. Setaria shows the greatest depth and spread of roots, but the other species exhibit more branching of a larger number of extra nodal roots, thus attaining the same end. Each bud derived from the stool is usually associated with two crown roots, in which case the bud development is normal, but when only one crown root is present the bud fails to grow out. In all three species the inflorescence is a spike, and the embryos are of the usual type. In *Poa pratensis*, however, polyembryony is frequent, and arises in various ways, the various types of abnormality apparently being due to the sting of an insect. A useful bibliography and a series of clear plates add to the value of this communication.

BRAZILIAN METEOROLOGICAL SERVICE.—Yearly volumes of meteorological observations at Rio de Janeiro and at numerous stations in Brazil for the three years 1912, 1913, and 1914, under the superintendence of Señor Sampaio Ferraz, have recently been received. Each volume contains about 100 pages of tabular matter. The observations at Rio de Janeiro are similar in detail to those made at European observatories, hourly values being published of rainfall and sunshine, and detailed monthly results of general meteorological phenomena. In many cases the results are compared with the mean results for more than thirty years. The observations for the provinces are on a uniform scale and the monthly and yearly results can be combined or compared with others in different parts of the world. Wind frequency is regularly recorded and also the mean velocity, so that knowledge of surface winds is readily available for aircraft; the results are in every way a valuable addition to the world's meteorology. Each volume contains tables and maps showing the rainfall for the first six months and second six months of the year, and for the year as a whole, at stations covering Brazil, the various falls being shown in the maps by degrees of shading. Generally the two halves of the year have very different rainfalls. In each of the three years the total rainfall reached 118 inches at one or more stations; in 1914 there were four stations with a rainfall exceeding 118 in., the maximum being 3596 mm., or 142 in., at Remate de Males, Amazonas; this place had the heaviest rainfall in two of the three years. The total annual rainfall at Rio de Janeiro ranged from 36 to 38 inches in the three years.

HEAT CONDUCTIVITIES OF METALS UNDER PRESSURE.—Volume 15 of Contributions from the Jefferson and the Cruft Laboratories of Harvard University is dedicated to Prof. E. H. Hall, who for more than forty years has been a member of the Harvard faculty. The volume is a reprint of 31 papers by the staff and students which have appeared in scientific and technical journals and proceedings of societies during 1921 and 1922. Eight of these papers are by Prof. Duane and his pupils and deal with various properties of X-rays. Six are by Prof. Bridgman, and one of these deals with high-pressure experiments. The heat conductivities of eleven metals have been measured up to pressures of about 12,000 atmospheres by the bar or by the cylinder method. The rate of change with increase of pressure is fairly uniform for each metal, the total change for the maximum pressure being an increase for lead of 21 per cent., tin 15 per cent., zinc 2·5 per cent., and a decrease for iron of 0·3 per cent., copper 9 per cent., silver 4 per cent., nickel 14 per cent., platinum 2 per cent., bismuth 38 per cent., and antimony 25 per cent. Between these results and those obtained previously by Lussana there are serious differences. The ratio of the thermal to the electrical conductivity is considerably changed by pressure, a result not in accord with the electron theory of conduction.

Photosynthesis.

GREAT interest was taken in the joint discussion on photosynthesis between the sections of Chemistry and Botany during the British Association meeting at Hull. The discussion was presided over by Prof. H. H. Dixon, who was supported by Principal J. C. Irvine.

The discussion was opened by Dr. F. F. Blackman with a paper entitled "The biochemical problems of chloroplastic photosynthesis." Dr. Blackman said that as the next two speakers were to take up the special aspects of photochemistry and energetics he would restrict his remarks to certain other aspects. He would deal with the active system of photosynthesis and its organisation in the living cell and bring together the evidence which supported the thesis that here we have to do, not with a simple photochemical reaction, but with a complex system in which other components, that might be described provisionally as protoplasmic components, play an essential part.

The first point developed was that there are numerous lower plants which obtain all their carbon by the reduction of CO_2 in the dark without the intervention of radiation, and synthesise all their organic compounds from this source. Here there is utilised the chemical energy of the oxidation of nitrogen, sulphur, or their compounds. In these chemosynthetic organisms there is not a gain of energy, but only an exchange of oxidation potential: the gain to the organism is substance for growth. It may be asked whether this power is entirely absent in the higher plants and what connexion the chemical machinery of it has with the chemistry of photoreduction of CO_2.

The second point was the fact, now thoroughly investigated, that the seedlings of many plants at a stage when they have developed chlorophyll to a full green colour may be quite incapable of reducing CO_2 in light, and give out as much CO_2 from respiration in light as in darkness. Some other component or property lags behind the chlorophyll in its development, and the slow, steady rate of its development is the same in darkness or light.

A third point of interest is the efficiency of photosynthesis in the golden-leaved varieties of certain shrubs. Here the amount of chlorophyll may be as low as 4 per cent. of the normal green form and yet under medium conditions the reduction of CO_2 may be as great as in green leaves. The fact has been established that the golden leaf needs more light than the green to carry out the same rate of reduction of CO_2. It looks as if with these extreme variations of chlorophyll what counted was the cube root of the amount of chlorophyll present—a single dimension of the colloid micellæ and not the total mass—which may be taken as an indication of the organisation of the system.

A fourth point considered was the relation of photosynthesis to temperature. It is established that for a high rate of photosynthesis it is not sufficient to have intense radiation and concentrated CO_2, but a high temperature is also essential. For each temperature there is a specific maximum of activity which cannot be exceeded unless the temperature is raised. The specific maximal values increase rapidly for rising temperature, having a temperature coefficient of about 2 for a rise of 10° C. This temperature relation is quite different from that of a pure photochemical reaction, and it provides a further indication that we have to deal with a complex system in which dark reactions may play a controlling part.

The fifth point to be raised had to do with the organisation of the active system. Warburg in investigating the action of the narcotic phenylurethane upon the rate of photosynthesis finds that the process undergoes great depression of rate with perfect recovery on removal of the narcotic. The relation of the depression to the external concentration of the drug gives a typical adsorption isotherm, indicating that the narcotic acts by adsorption on a surface from which it displaces temporarily some reactant substance of the active photosynthetic system.

Taking all these pieces of evidence together, Dr. Blackman considered that we are forced to conclude that the chloroplast contains an active system of several components related together in a complex organisation.

Prof. E. C. C. Baly then presented the results of experimental work on photosynthesis carried out at Liverpool. The conversion of a substance A into substance B might, he said, be represented as the sum of the three equations:

$$\begin{aligned} A + E &= A' \\ A' &= B' + F \\ B' &= B + G \end{aligned}$$

where E, F, and G are quantities of energy and A′ and B′ represent the reactive forms of A and B. The reaction is exo- or endo-thermic according as $F + G - E$ is positive or negative. In any case a quantity of energy, E, must be supplied in order to start the reaction, and this may be done by means of (1) heat, (2) light, or (3) a material catalyst. Now the energy can only be supplied in "quanta," and if E is large, only the use of radiation of short wave-length makes the number of "quanta" to be introduced sufficiently small to be practicable. For the conversion of a molecule of carbonic acid into formaldehyde and oxygen 150,000 calories are necessary, and this can be supplied in a single quantum by radiation at wave-length $200\mu\mu$. Carbonic acid has an absorption band at this frequency and formaldehyde ought therefore to be produced when a solution of CO_2 in water is exposed to ultra-violet light. This has now been shown to take place.

In order to bring about the reaction by means of *visible* light it is necessary to have present a coloured substance with basic properties, and Malachite Green has been found to fulfil the conditions. There seems little doubt that the formation of formaldehyde in the leaf takes the following course:

i. Chlorophyll A + H_2CO_3 + light = Chlorophyll B + CH_2O.
ii. Chlorophyll B + Carotin = Chlorophyll A + Xanthophyll.
iii. Xanthophyll + light = Carotin + Oxygen.

The photosynthesised formaldehyde is extraordinarily reactive and is best represented by the formula CHOH. It is polymerised rapidly to a mixture of carbohydrates, in which are found hexoses (20 per cent.), cellulose, and cane-sugar. In the presence of nitrite it is converted into formhydroxamic acid and hence into amino-acids and a mixture of cyclic bases in which pyrrole, pyrrolidine, pyridine, coniine and glyoxaline have been detected. The active (energised) forms of the aminoacids are the immediate source of proteins.

Mr. G. E. Briggs described some experiments to determine the relation between the radiant energy absorbed and the carbon dioxide assimilated by the green leaf (*Phaseolus vulgaris*) in different parts of the visible spectrum. For three different parts of the spectrum the carbon dioxide assimilated was measured, and the energy absorbed by chlorophyll *a*

and chlorophyll *b* was estimated from data obtained, due allowance being made for the energy diffusely reflected by the leaf. The results were of the following order: for the yellow-red (570-640$\mu\mu$), 15 calories per c.c. of carbon dioxide, for the green (510-560$\mu\mu$), 7, and for the blue (430-510$\mu\mu$), 22 +, these being maximal values.

Mr. Briggs pointed out that since the heat of formation of the most probable products of assimilation ranges from five to six and more calories per c.c. of carbon dioxide, the indications are that both chlorophyll *a* and chlorophyll *b* take part in the photochemical reaction. Referring to Prof. Baly's suggestions as to the part played by the different pigments in the photosynthetic process, he said that since the quantity of each pigment underwent relatively little change during prolonged assimilation no energy was supplied from this source, and, further, that since as much oxygen was evolved as carbon dioxide absorbed in the red and the green parts of the spectrum—regions where no energy is absorbed by the xanthophyll—as well as in the blue, it was not necessary to postulate a photochemical reaction involving xanthophyll in order that oxygen might be liberated.

Prof. I. M. Heilbron and Mr. C. Hollins put forward some speculations on photosynthesis. The large number of plant products in which the predominant carbon nucleus is C_5 or a multiple of this suggests that this unit has a special significance. The photosynthesised reactive hexose may be supposed, in addition to its further condensation to sugars, cellulose, glucosides, etc., to furnish by dehydration ω-hydroxymethylfurfural. This by oxidation and decarboxylation can give a stabilised C_5 compound, which, either as the furan derivative or (by opening of the ring) as dihydroxyglutaconic dialdehyde, may be a source of pentoses and of condensation products of these. Simple schemes were suggested showing how two, or three, molecules of a "pentose" can give rise by ordinary condensation reactions to anthocyans (C_{15}), terpenes (C_5, C_{10}, C_{15}, etc.), coniferyl alcohol (C_9), and the numerous related compounds, coniine (C_8) and the phonopyrrolecarboxylic acids (C_8, etc). The degradation of hexose into "pentose" represents the respiration of the plant. Against the suggestion of Robinson (British Assoc., 1921) that anthocyans result from the condensation of two hexose and one triose molecule are to be set the absence of nonoses in Nature and the failure of all attempts to obtain benzene derivatives from hexoses.

Papers were also contributed by Dr. F. C. Eve and Prof. M. C. Potter.

Prof. R. Robinson thought that the accumulation of active formaldehyde and formhydroxamic acid scarcely accounted for the almost inexhaustible variety of plant products. The alkaloids were probably produced from hexoses rather than built up atom by atom from formaldehyde. He was unable to accept the suggestions of Prof. Heilbron and Mr. Hollins as to the significance of the C_5 unit. The anthocyans he preferred to consider as $C_6 + C_3 + C_6$ rather than $C_5 + C_5 + C_5$. Although nonoses had not been found in Nature, E. Fischer had obtained a nonose which was fermentable.

Dr. E. F. Armstrong emphasised the importance of cane-sugar in the carbohydrate metabolism of green leaves.

Prof. Baly briefly replied to some of the points which had been raised, and the discussion was then closed by a few remarks from the chairman, Prof. Dixon.

Progress in Engineering.

THE James Forrest lecture delivered in 1903 by Dr. W. H. Maw dealt with some unsolved problems of engineering; his presidential address, read before the Institution of Civil Engineers on November 7, directs attention to the progress which has been made towards the solution of certain of these problems. In ordinary researches the conclusions arrived at often remain untested for more or less long periods, and when they are tested it is not unusual for such tests to develop facts which, if known earlier, would have decidedly affected the character of the research carried out. During the war, especially in aeronautical researches, immediate results were wanted, and reasonable suggestions arising from research were, as a rule, tested without delay. As a result conclusions were arrived at and advances made much more promptly than would have been possible under other conditions.

For many years past there has been steady growth in the demands for larger structures and machines. In the case of bridges there are three ways in which increases of span may be made commercially attainable: First, by improvements in the structural designs; second, by the reduction of the so-called factors of safety now adopted; third, by the use of improved structural materials and constructive details. Dr. Maw does not think that there is much chance of obtaining material aid by the first of these methods; it does not appear likely that any new type of design will be evolved possessing striking advantages as compared with those already known and investigated. The prospects from the second method are better; there are two classes of allowances, namely, (*a*) stresses due to wind pressures, changes of temperature, and so on, which depend upon local circumstances and other matters of individual judgment, so that a reduction cannot be calculated upon, and (*b*) allowances which depend upon the quality of all the materials used and the soundness of the workmanship. The allowances under the latter head might be materially reduced as compared with those considered necessary even ten years ago. During that period, vast improvements have been made in our steel manufacturing processes, especially in the direction of ensuring uniformity of quality, while the facilities for thorough testing and inspection have been enormously increased.

In reference to the third way, there are no indications that we have reached the limits of progress in the use of improved structural materials. In long span bridges, the importance of the "specific tenacity" of the material (*i.e.* the ultimate strength in tons per sq. inch divided by the weight in pounds of one cubic inch) is exceedingly great, since the weight of the structure itself forms the larger portion of the total load supported. The successful manufacture, on a commercial scale, during recent years, of various high-quality alloy steels has quite changed the aspect of affairs and has materially enlarged the limits of the practically permissible spans of different types of bridges. At present, the most hopeful line of progress appears to lie in still further improvements in alloy steels and their treatment. Research work bearing on this subject is being vigorously prosecuted by our leading steel makers and affords every ground for expecting substantial advances.

Improvements in metallic alloys have been rendered possible by the revelations of microscopical research. Prior to the development of this type of analysis,

we knew that steel subjected to a certain heat treatment had its mechanical qualities altered. Microscopic investigation, aided by improvements in the preparation and treatment of the samples to be examined, has enabled us now to trace out, step by step, the changes which take place at various stages of the treatment, as well as the effect—in the case of alloys—of modifications in the proportions of the constituents. Microscopic research also promises to be of value in providing definite information as to the changes of structure in different metals when injured by fatigue, or are just on the point of fracture, and Sir Robert Hadfield has made some valuable experiments in this direction.

During the last few years a most important addition has been made to our methods of discovering defects in materials or workmanship by the application of the X-rays. Great progress has been made, and there is every promise of further developments in the early future. At present steel or iron can be searched to depths of about 3 inches, aluminium and its alloys to about 6 inches, and timbers of various kinds from about 15 to 20 inches.

Researches on the thermal efficiency of the steam engine during the last few years have related chiefly to the development of the steam turbine. Prior to 1903 the best economical result obtained with a steam turbine was that of a 1500-kilowatt alternator built by Messrs. Parson in 1902; this machine had a steam consumption corresponding to about 13·5 lb. per indicated horse-power per hour. A test carried out in 1918 on a 10,000-kilowatt unit by the same makers gave a consumption of 7·75 lb. per horse-power per hour—a reduction of about 43 per cent. on the 1902 performance. The corresponding thermal efficiency is nearly 27·7 per cent. Bearing in mind certain points in the design of this turbine and making allowance for them, it appears that a thermal efficiency of 30 per cent. for a steam motor is within our reach.

Mechanical gearing in turbines has proved in a number of cases to be unsatisfactory. The question of how to prevent the defects which have occurred forms probably the most important problem which has demanded the attention of mechanical engineers for many years past. The failures have been variously attributed to the use of unsuitable metal for the gears, to irregularity in the gear cutting, to disturbance in the alignment of the shafts and to other causes. The whole subject deserves more systematic and thorough investigation than it has received hitherto.

The development of the steam turbine has been the result of an enormous amount of strenuous and original work, both theoretical and constructional. On the theoretical side, the determination of the laws controlling the discharge of steam through orifices of various shapes is yet very far from being complete, and there are many other problems, such as the critical speeds of shafts, the best number of stages to be adopted under different conditions, and so on. On the constructional side may be mentioned the selection of suitable materials for the blades and the mode of fixing the latter, devices for preventing steam leakage, securing efficient lubrication, and methods of governing and of obtaining the high vacua so essential for securing economic performance.

The pistons of reciprocating engines have speeds ranging from 600 to 800 feet per minute. In steam turbines the blades are being run successfully at 600 feet per second. A small turbine (150 horse-power), made recently by Messrs. Ljungström of Stockholm, runs at 40,000 revolutions per minute and has a blade speed of 952 feet per second—more than 11 miles per minute.

In conclusion, Dr. Maw directed attention to one fact which appeared to him of far greater importance than all the others: in none of the researches referred to, varied and extensive as they have been, is there the slightest trace of finality. Much as has been discovered and great as has been the progress made, it is most certain that we have at present effected only the preliminary opening up of the mine of knowledge and that the real wealth of its contents is as yet unknown to us. We can only say that the "impossible" of yesterday has become the "possible" of to-day, and in the early future many of these possibilities bid fair to become accomplished facts. Surely this is a great inheritance, which should invite our coming generations of engineers to make most strenuous efforts to secure greater—and still greater—developments, so that they may in their turn leave behind them a heritage more glorious still.

Radio-Telephony and Broadcasting.[1]

By A. P. M. FLEMING, C.B.E.

IN considering the development of radio-telephony, it is frequently overlooked that the earliest methods of communication, such as by sound and light, do not involve the use of wires; the negative and non-descriptive term "wireless" has, therefore, been displaced by the term "radio." Radio waves are electro-magnetic in character, being pulsations in the æther of space, and they differ among themselves and from radiant heat, light, and X-rays, only in their amplitude and wave-length. Some waves change and diminish gradually in amplitude, and are said to be "damped"; others maintain their amplitude and are "continuous." Radio waves exist and are used which vary in wave-length from a few yards to ten or twelve miles; they are the longest electro-magnetic waves.

Given the means whereby electrical waves can be produced and detected, it is comparatively simple to arrange to send signals by the morse code, and this is done every day in ordinary radio-telegraphy. Radio-telephony is in some respects analogous to ordinary telephony. The ordinary telephone circuit of microphone transmitter, line, and receiver contains a battery which sends a continuous current round the circuit and through the telephone receiver. If speech is made in the microphone, the vibration of the microphone diaphragm varies the pressure on carbon grains in the microphone. This varies the resistance in the battery circuit, and the current, instead of flowing steadily, rises and falls according to the sound waves impinging on the transmitter diaphragm. The fluctuating current varies the pull on the diaphragm in the telephone receiver, and this sets up sound waves similar in character to those originally spoken into the transmitter. In radio-telephony there is a generator capable of producing very high-frequency oscillating current which can be radiated from an aerial, just as heat and light are radiated from a fire or lamp. This radiated oscillation is known as a "carrier wave." Near the generator is a modulator receiving the speech and modifying the amplitude of the high-frequency oscillation, and imparting changes in the carrier waves in

[1] Substance of a lecture delivered at a meeting of the North-east Coast Institution of Engineers and Shipbuilders, Newcastle-on-Tyne, on Friday, December 15.

accordance with the speech vibrations, which result in a fluctuating current radiated to the receiver.

At the receiving end the oscillating current is changed into a uni-directional current, and made suitable for reception for hearing in an ordinary telephone receiver. It is an essential condition of reception that the receiving set be "tuned" to respond to the wave-length of the station it is desired to hear. Electrical waves emanating from a transmitter travel in all directions through space, and can be picked up by any number of receivers, provided these are tuned to receive the particular wave-length used.

Broadcasting stations comprise transmitting-room, studio, green-room, offices, listening-in room, and workshop. Programmes are designed to operate throughout the whole evening, and all tastes and ages are catered for. It is usual for artistes to operate at the station, but by means of ordinary telephone transmission it is possible to transmit a political speech or entertainment from a central hall in a city to the broadcasting studio, and to radiate it from the station to listeners.

The pioneer work in broadcasting as a means of public entertainment and instruction was undertaken by the Westinghouse Co. of Pittsburgh, U.S.A., in December 1920. The Metropolitan-Vickers Co. of Great Britain has close technical association with this company and has the advantage of this pioneer experience. There are now more than 500 broadcasting stations in the United States, and their growth without proper co-ordination has caused some confusion.

To avoid this confusion in Great Britain, the Government insisted that manufacturers of radio apparatus should co-operate in forming a Broadcasting Company to control broadcasting. Three stations of the eight contemplated are in operation, London, Manchester, and Birmingham, and it is intended that Newcastle shall have a station. The revenue of the Broadcasting Company for maintaining stations is provided by the manufacturers, but the Government assists by remitting a proportion of the licence fee.

Care should be taken in selecting a set suitable to the local conditions. A good crystal set costing about four or five pounds will receive satisfactorily over ten or fifteen miles. A two-valve set would pick up over fifty or one hundred miles, and in addition to this, a further two-valve amplifier could be arranged to increase the distance to 300 miles, or would permit the use of a loud speaker up to fifty miles. Sets sold by reputable manufacturers are very efficient and simple to operate.

The development of radio-telephony will have a very profound influence upon social life. It will overcome the isolation of the rural worker, the invalid, and those who are confined indoors, and it has unique potentialities for entertainment, instruction, and the development of public taste.

Excavations at Borg en Nadur, Malta.

AT a meeting of the Royal Anthropological Institute held on November 21, Prof. F. G. Parsons, vice-president, in the chair, Miss Murray gave an account of some excavations carried out by her at Borg en Nadur, Malta, during the past summer. The excavation was purposely limited to a small area to the west of the so-called "dolmen" of Borg en Nadur in a terraced field which had been made over this site, as high as the cap-stone of the dolmen, and completely covering the remains of the ancient buildings. The principal building found was an apsidal structure of the type peculiar to Malta. From the small size of the stones and the primitive style of the building, Miss Murray is of the opinion that Borg en Nadur is considerably older than Mnaidra and Tarxien. The principal results of the excavation are (1) the discovery of types of pottery transitional between the neolithic and bronze age; (2) the finding of painted pottery showing Cretan influence, perhaps of the Middle Minoan era, thus connecting prehistoric Malta with another ancient civilisation.

In the discussion which followed the reading of the paper, Prof. J. L. Myres said the pottery of Malta presents a puzzling problem. Evidence is needed as to which of the large number of types are contemporary. The pottery from the "window tombs" of the lower levels of the ravines with flat alluvial bottoms, which form the characteristic watercourses of Malta, presents certain affinities with the "Sikel" pottery of Sicily. Miss Murray distinguished between "neolithic" and "bronze age" pottery; but, whereas she found the latter at ground level in the apsidal building, at Hal Tarxien the lower occupation layer, resting on ground level, contained no metal, and the bronze age interment had been found over a sterile layer of some thickness imposed upon the neolithic stratum and at a considerable height up the great stones of the temple. The painted pottery, for which a Cretan affinity had been suggested, is of the type found in Sicily and Southern Italy for which Prof. Peet had traced a Thessalian rather than an Ægean relationship. Prof. Myres also expressed his opinion that the Borg en Nadur building was of late and degenerate type rather than early and primitive. Mr. H. J. E. Peake said that Miss Murray's suggestion of a type of pottery transitional between the neolithic and bronze age types was new and needed substantiation. The restricted distribution of the "bronze age" type suggested that it might be an intrusion, of which Miss Murray's transitional type was an attempted copy.

University and Educational Intelligence.

BIRMINGHAM.—Dr. Dorothy Margaret Patrick has been appointed assistant lecturer in physiology, Grade III.

Mr. T. V. Barker, of the department of mineralogy at Oxford, has been invited to deliver a course of lectures, during the spring term, on chemical crystallography.

The annual meeting of the Court of Governors will be held on Thursday, February 8.

The vice-chancellor (Sir Gilbert Barling, Bart.) is to represent the University at the celebration of the 800th anniversary of the foundation of St. Bartholomew's Hospital in June next.

The new hall of residence for men students is to be known in future as Chancellor's Hall.

GLASGOW.—The University has received a gift of 25,000*l.* from Mr. Henry Mechan, of Mechans, Limited, engineers and contractors, Glasgow, for the foundation of a new chair of public health.

LONDON.—At a meeting of the Senate on December 13, a resolution was adopted accepting a bequest of 3000*l.* made by the late Sir William Meyer, fellow of University College and High Commissioner for India, to be applied at the discretion of the Senate "with special reference to the encouragement of proficiency in European History, and in the History and Geography of India." An offer from the council of the Society of Antiquaries to continue the Franks studentship in archæology, of the value of 100*l.* per annum, for a further period of five years was accepted with thanks.

A grant of 15*l.* from the publication fund of the University has been made to the hon. editor for zoology of the *Annals of Applied Biology* in aid of the publication in that journal of the M.Sc. thesis entitled "The Life-History and Bionomics of the Turnip-Gall Weevil," by Mr. P. V. Isaac.

The degree of D.Lit. has been conferred on the Rev. G. H. Dix, an internal student, of King's College, for a thesis entitled "'The Angel of Jahweh': A Study in the Origin and Development of a Religious Folk-Legend, with special reference to the Messianic Expectation of the Hebrew Race."

THE general meeting of the Association of Women Science Teachers will be held at University College, Gower Street, on Saturday, January 6, 1923. The programme includes an address by the retiring president and a lecture on relativity by Dr. Dorothy Wrinch. The hon. secretary of the association is Miss E. M. Ridley, 10 Gresley Road, N.19.

THE annual meeting of the Geographical Association will be held in Birkbeck College, London, E.C.4, on Thursday and Friday, January 4 and 5, 1923. Sir John Russell will deliver his presidential address on the subject of "The Influence of Geographical Factors in the Agricultural Activities of a Population" on the opening day of the meeting. Among lectures to be given during the meeting are: "Types and Materials of Houses in England," Mr. H. Batsford; "The Place of Geography in the Education of the Adolescent," Dr. Olive Wheeler; "Geography and Business Life," Prof. W. S. Tower; "The Coming Industrialisation of China," Prof. P. M. Roxby.

THE second annual general meeting of the Association of Heads of Departments in Pure and Applied Science was held on Saturday, December 9, at the Woolwich Polytechnic. The members were welcomed by the chairman of the Governors, Mr. C. H. Grinling, who delivered an address upon the desirability of "association" in all branches of society, whether trade or professional, commercial or political. He emphasised the importance of a new association taking a long view of the range of their activities and of developing into a body of national, or better still, of international, rather than of merely parochial importance. The meeting decided later to extend the activities of the association by the admission of members from the provinces. Mr. C. E. Larard, of the Northampton Polytechnic, was elected as chairman, and Dr. W. A. Scoble and Mr. R. T. Smith, of Woolwich Polytechnic, as joint secretaries for the ensuing year.

THE report for 1921–22 by Dr. Cranage on the Cambridge University Local Lectures shows that the revival which took place in 1919–21 has been maintained as regards the number of courses (92, of which 15 were on scientific subjects), but that the average attendance per lecture dropped from 142 in 1920–21 to 127, and per class from 38 to 33. The Summer Meeting (July 29 to Aug. 18) was attended by 544 students of whom 444 were women and 46 from foreign (chiefly Scandinavian) countries. The corresponding figures for 1912 are 565, 377, and 226. Considering that board and lodging were about twice and rail fares about three times as expensive as before the war, the popularity of the Summer Meeting is remarkable. Next July there will be held at Cambridge in connexion with the jubilee of the local lectures a conference on extra-mural teaching, the Chancellor presiding at the first meeting.

FROM the annual report for the year 1921–22 issued by the Rhodes Trust, it appears that the number of Rhodes scholars in residence during the year was 300, of whom 156 came from the British Empire and the remainder from the United States. Of the total, 66—more than one-fifth—took natural science, a term which includes those studying medicine; in addition, forestry and mathematics each had five scholars, agriculture three and anthropology one. During the year, 72 took up their scholarships for the first time. The current academic year commenced with 262 scholars in residence. The value of the Rhodes scholarship has been temporarily increased by an annual bonus of 50*l.*, but applicants are warned that even thus, they must be prepared to find another 50*l.* a year. Appointments to the 1924 scholarships will be made during the year 1923; further information can be obtained from the offices of the Rhodes Trust, Seymour House, Waterloo Place, London, S.W.1.

THE Universities Bureau of the British Empire has published an abridged report of the proceedings of the annual conference of the universities of Great Britain and Ireland held last May. Four subjects were discussed: (1) the urgent need for enlarged opportunities for advanced study and research in the British universities; (2) the increase of residential accommodation for students; (3) specialisation in certain subjects of study by certain universities; (4) the organisation of adult education as an integral part of the work of the universities. Mr. H. A. L. Fisher, then president of the Board of Education, attended the conference and took part in the discussion of subject (3), which he considered to be pre-eminently a subject for conference and co-operation among the universities, especially in regard to the financial requirements of new specialised departments, the application to the best advantage of existing trust funds in universities, and the migration of research students. The Report (pp. 32, price 1*s.*) is obtainable from the Universities Bureau, 50 Russell Square, W.C.1.

THE eleventh annual conference of Educational Associations will be held at University College, Gower Street, W.C.1, on December 28–January 6, under the presidency of Sir Michael Sadler, Vice-Chancellor of the University of Leeds. The inaugural meeting will be held at Bedford College for Women, Regent's Park, on the afternoon of December 28, when Sir Michael Sadler will deliver his presidential address. There will be two joint conferences of all the societies during the meeting—one on the methods of carrying out in schools the recommendations of the reports on the Teaching of Classics, Modern Languages, English and Science, on December 30, and the other, "How can the Links in the Chain of Education be strengthened?" on January 5. The College of Preceptors will also hold a discussion, opened by Sir Michael Sadler, on the growth of bureaucracy in education. Among the papers which have been promised are: four to be delivered to the National League for Health, Maternity and Child Welfare—on physical development and its food requirements, by Dr. E. Pritchard, on physique and growth, by Dr. James Kerr, on child psychology and psychotherapy, by Dr. William Brown, and on health education, by Prof. H. Kenwood; three lectures on reform and tradition in education, by Mr. Frank Roscoe, to the College of Preceptors; a paper on the child and the cinema, by Dr. C. W. Kimmins, at the British Psychological Society (Education); another on the co-ordination of the teaching of mathematics with handicraft, by Mr. A. Romney Green, at the Society for Experiment and Research in Education; one on hygiene as applied to physical training, by Prof. M. E. Delafield, at the Incorporated British Association for Physical Training; and one on relativity, by Dr. Dorothy Wrinch, at the Association of Women Science Teachers.

Calendar of Industrial Pioneers.

December 24, 1872. William John Macqueen Rankine died.—The author of a series of valuable engineering text-books, Rankine was a distinguished engineer and physicist, and with Clausius and Kelvin helped to found the modern science of thermodynamics. A student first at Glasgow Academy and then of the University of Edinburgh, he gained practical experience in railway engineering under M'Neill and Locke, and in 1855 succeeded Gordon in the chair of civil engineering in Glasgow University.

December 25, 1868. Linus Yale, Junior, died.—The son of Linus Yale, senior (1797–1857), a successful inventor of locks, Yale was born in 1831 and began life as a portrait painter. Joining his father in 1849 he contributed much to the success of the firm, and during 1860–64, by the adoption of an old Egyptian device, worked out his well-known pin-and-tumbler lock for the production of which the Yale Manufacturing Company was organised at Stamford, Connecticut.

December 27, 1883. Andrew Atkinson Humphreys died.—Humphreys graduated from the United States Military Academy, served in the Bureau of Topographical Engineers and the United States Coast Survey, and made a long study of the problem of controlling the waters of the Mississippi, his work on which raised him high among hydraulic engineers.

December 27, 1890. William John died.—Trained as a naval constructor under the Admiralty, John was regarded as one of the ablest and most original constructors of his day. He wrote on stability, the strength of iron ships, and other subjects, and from 1881 to 1888 was manager of the Barrow Shipbuilding Works.

December 27, 1896. Sir John Brown died.—One of the first to develop successfully the Bessemer process, Brown introduced into Sheffield the manufacture of steel rails, and at the Atlas Works, in 1863, rolled an iron armour plate twelve inches thick and fifteen to twenty feet long.

December 27, 1900. Sir William George Armstrong, Baron Armstrong of Cragside, died.—A solicitor, who became a great engineer, Armstrong was a pioneer in the use of hydraulic machinery, the rival of Krupp as an improver of artillery, and an organiser of outstanding ability. Born in Newcastle in 1810 he practised as a solicitor there; in 1846, he invented his hydraulic crane, and the following year became the first manager of the Elswick Engineering Works. In 1854 he brought out a breech-loading rifled gun, in 1859 founded the Elswick Ordnance Works, and in 1880 built a six-inch wire-wound gun. He was assisted by Rendel, Noble, Vavasseur, and others, and the Elswick Works were afterwards amalgamated with those of Mitchell and Swan and of Whitworth.

December 28, 1907. Coleman Sellers died.—A distinguished American mechanical engineer, Sellers was for many years connected with the firm of William Sellers and Co., of Philadelphia. Retiring in 1887 he became a consultant, and was actively engaged in the pioneering schemes for the utilisation of the power of the Niagara Falls.

December 30, 1910. Fredrik Adolf Kjellin died.—Known for his original work on electric smelting, Kjellin was trained at the Technical High School of Stockholm and became metallurgical chemist at the Gysinge works of the Aktiebolaget G. Benedicks, where, in 1899, he constructed the first induction furnace.

E. C. S.

Societies and Academies.

LONDON.

Geological Society, December 6.—Prof. A. C. Seward, president, and afterwards Mr. R. D. Oldham, vice-president, in the chair.—H. A. **Baker**: Geological investigations in the Falkland Islands. The stratigraphical succession comprises rocks of Archæan, Devono-Carboniferous, and Permo-Carboniferous age. There is only one exposure of Archæan rocks, namely, in the cliffs of Cape Meredith, the southernmost point of West Falkland. Overlying these old rocks, and separated from them by a strong unconformity, are coarse sandstones and quartzitic rocks, nearly horizontal. This unfossiliferous series is of great thickness, probably about 5000 feet. It occupies the southern part of West Falkland and the islands lying to the west of this area. It is regarded as of Devonian age. The succeeding series of rocks, of Devono-Carboniferous age, occupy the remainder of West Falkland (except for small areas of Permo-Carboniferous rocks) and the northern half of East Falkland. The Middle and Upper Series each include about 2500 feet of strata. Terrestrial deposits of Permo-Carboniferous age follow. They occupy a synclinorium extending over the whole of the southern half of East Falkland (Lafonia) and Falkland Sound. They include a thickness of strata exceeding 9000 feet. A sandstone formation (Lafonian Sandstone) of no great thickness follows, and is, in turn, succeeded by more than 6000 feet of terrestrial deposits. Several thousand feet of these Upper Lafonian Beds consist of a monotonous alternation of thin sandstones and shaly beds. Doleritic dykes are of frequent occurrence; their age is post-Upper Lafonian. The marine fauna will probably prove to be of Upper Devonian age. The Falkland Islands appear to owe their existence to the fact that they occur at the crossing-place of two sets of folding movements.—A. C. **Seward** and J. **Walton**: On a collection of fossil plants from the Falkland Islands. A Devonian age is suggested for the oldest plant-bearing beds. Numerous examples of Glossopteris leaves were collected, especially in Lafonia, of species which are not confined to one geological series in the Gondwana System. Many specimens of Equisetaceous stems were also obtained from the Glossopteris Beds: of these several are identical with Falkland examples described by A. G. Nathorst and by T. G. Halle, while others are compared with an Upper Triassic or Rhætic species *Neocalamites carrerei* (Zeiller). A comparison of petrified wood, most of which has been assigned by various writers to the genus Dadoxylon, from different parts of Gondwanaland, points to the prevalence, in the southern botanical province, of trees differing in anatomical characters from contemporary plants in the northern province. The Permo-Carboniferous flora seems to agree most nearly with the Damuda and Beaufort Series of India and South Africa respectively. The stems compared with Neocalamites favour a reference of the beds at Cygnet Harbour and Egg Harbour to a somewhat higher position; and, on the other hand, the leaves described as *Glossopteris indica* Schimper (cf. *G. decipiens* Feistmantel) from North Arm, although they represent a type which has a wide range both in space and in time, suggest a possible correlation with the Ecca Series of South Africa and the Talchir Series of India.

CAMBRIDGE.

Philosophical Society, November 27.—Mr. C. T. Heycock, president, in the chair.—C. T. R. **Wilson**: On some α-ray tracks. (1) The track of an α-particle from an atom of thorium emanation, together with

that of the α-particle emitted immediately afterwards by the resulting thorium-A atom. Some remarkable features on these tracks were explained as due to the action of previously formed tracks in robbing the air of its excess of water vapour. (2) Photographs of α-ray tracks showing short-range β-rays radiating from them—Bumstead's δ-rays, of which photographs were obtained by him in hydrogen. From the range of the longest δ-rays their velocity reaches values twice that of the α-particle. The δ-rays do not appear on the last two centimetres of the α-ray tracks. In the neighbourhood of the initial portions of the α-tracks minute detached cloudlets are visible —probably the tracks of β-particles produced by soft X-rays (K-radiations from atoms traversed by the α-particle).—A. B. **Appleton**: The interpretation of the pelvic region and thigh of Monotremata. An extensive comparison of thigh musculature forms an essential preliminary to the tracing of changes in the form of the femur and pelvis among Tetrapoda. The destination of nerve-fibres and their course in regard to pelvic-girdle and muscles provide the best guide to the identification of muscles. The myology and nerve-distribution of various mammalian and other tetrapod groups has been carried out as a preliminary to the identification of Monotreme muscles. Monotremata exhibit most of the characteristics of the mammalian thigh. A somewhat divergent evolution has taken place with retention of certain reptilian features. The lesser trochanter of mammalia is a different structure from the internal trochanter of reptilia.—A. B. **Appleton** and F. **Goldby**: Observations on the innervation of the pubi-tibialis (sartorius) muscle of Reptilia. In some species of Lacertilia it is innervated from two nerve-trunks, as in Sphenodon. This is regarded as due to fusion of two muscle-elements. Certain Mammalia, Monotremata and certain Carnivora almost reproduce this form. In most other Mammalia, the pubi-tibialis muscle is represented only by the sartorius muscle (possibly also by the gracilis muscle), and the function has changed.—W. **Burnside**: The axioms of elliptic geometry.—W. M. H. **Greaves**: The periodic solutions of the differential equation for the triode oscillator.—C. G. F. **James**: Complexes of cubics in ordinary space.

EDINBURGH.

Royal Society, December 4.—Prof. J. W. Gregory, vice-president, in the chair.—Sir J. A. **Ewing**: The atomic process in magnetisation: further notes. A modified form of atomic model has been made which reproduces the distinctive features of both ferro- and paramagnetism. Taken in conjunction with Langevin's theory of diamagnetism, the new model appears to offer a general clue to the process of magnetisation in any solid body, whether ferromagnetic, paramagnetic, or diamagnetic. It is now generally recognised that the electrons, in consequence of orbital motion or otherwise, are in some way magnetic di-poles. If their grouping is not rigid and allows individual electrons to have their magnetic axes reversibly deflected against a strong controlling force, we find the phenomena of paramagnetism. As regards ferromagnetism, the group might be initially unsymmetrical, having a resultant moment, so that it could serve as the Weber element in a ferromagnetic process. In that case the phenomena of hysteresis are found when the group as a whole turns from one position of stability to another. The control under which such irreversible turning takes place is probably partly in the mutual action between the outer shell of electrons of any one atom and those of its next neighbours in the space-lattice, as well as in the mutual action from atom to atom of the groups which constituted the Weber elements. The magnetic axes of the groups tend to orient themselves in rows. At first, the group of electrons in each atom is deflected reversibly through a small range, after which there is a break away, and new rows are formed with a more favourable orientation. The control which causes the range of reversible deflection to be very narrow (as, for example, in iron) is ascribed to the forces (not exclusively magnetic) between electrons in juxtaposition in the outer shells of atoms. The contiguous atoms are regarded as turning simultaneously under the influence of the applied field, first reversibly through a small angle, and then irreversibly into new lines, which, in an iron crystal, are inclined at 90° or 180° to the old ones. When all the groups are turned in one direction, the magnetism is what is called saturated, but there may be a further increase of the magnetism through the reversible turning of the individual electron axes within any group.—A. P. **Laurie**: Experiments with a model to illustrate the combination of two atoms consisting of magnetons round a positive nucleus. If two atoms composed of rings of magnetons placed radially round a positive nucleus approach each other, then the magnetic lines of force between the two atoms are such that there must be two places of equilibrium for the two nearest magnetons—one in which they are when the atoms approach, and the other the position at right angles to this holding the two atoms together by means of the outer electrons. A model to illustrate this (Figs. 1 and 2) was constructed with four fixed coils to represent two of the outer magnetons of two separate atoms

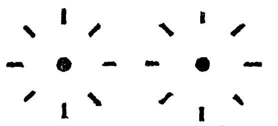

FIG. 1.
Two atoms before combination.

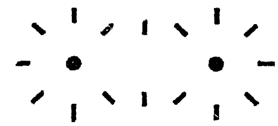

FIG. 2.
Two atoms after combination.

and with two moving coils, each able to turn on its own centre and on a common centre between them. On passing an electric current through the system the moving coils always arranged themselves in one position or another at right angles according to the placing of the four fixed coils. This suggests a new theory of valency—a valency not depending on the number of magnetons in the outer shell, but on the number of groups of three magnetons. There would be primary, secondary, and tertiary valencies, the combination of two atoms at once producing fresh groups of three electrons which lead to new valencies. An explanation of chemical combination is offered. —A. E. M. **Geddes**: Observations on the structure of the hydrogen lines H_α and H_β. Sommerfeld's theory demands a constant frequency separation of the components of spectral lines. The results obtained tend to indicate a gradual decrease in the separation. This appears to support M'Lennan's idea that the frequency separation gradually diminishes and vanishes at the limit of the Balmer series.—D. M. Y. **Sommerville**: Division of space by congruent triangles and tetrahedra. The various ways in which it is possible to divide the plane into congruent triangles, and space of three dimensions into congruent tetrahedra, is discussed.—Sir Thomas **Muir**: The theory of alternants from 1896 to 1917.—H. W. **Turnbull**: Double binary forms. The (m, n) form $\Sigma\binom{m}{h}\binom{n}{k}a_{hk}z^{m-h}z_1{}^{n-k}$, $0 < h < m$, $0 < k < n$ is binary in both independent variables z, z_1. Relative to the independent linear transformations from z to z_1,

w, w_1 an invariant theory can be constructed. This theory has been studied principally by Peano, Kasner, and Forsyth, but only for values of m, n, not exceeding 2. The present paper is preparatory to a proof of Gordan's theorem—that the complete invariant system of the (m, n) form is finite. It is the algebraic theory answering to geometrical inversion.

PARIS.

Academy of Sciences, November 27.—M. Emile Bertin in the chair.—Marcel **Brillouin**: Einsteinian gravitation. Statics. Singular points. The material point. Various remarks.—E. **Fournier**: Experiments on the guidance of dirigible balloons through fog by the method of W. A. Loth: their consequences. The electrical method of M. Loth, originally designed for the guidance of ships into port in foggy weather, is equally applicable to aeroplanes and balloons. The guiding cable may be either aerial or buried in the earth. The latter method might be employed in establishing aerial communications across the Sahara. —L. **Guignard**: The existence of certain proteid bodies in the pollen of various Asclepiadaceæ.—Charles **Richet** and Mme. A. G. **Le Ber**: Studies on lactic fermentation. The action of very small doses of substances apparently inoffensive. Substances such as urea or milk, not considered poisonous, can exercise, even at very great dilutions, a distinct influence on the activity of the lactic ferment. It follows that bacteria, since they react to such slight influences, are never found under identical conditions of development.—A. **de Gramont**: Ultimate lines and spectral series.—P. **Fatou**: Certain uniform functions of two variables.—Spyridion **Sarantopoulos**: The number of roots of holomorphous functions in a given curve.—Alf. **Guldberg**: Mean values.—Jacques **Rueff**: Theory of the phenomena of exchange. Two principles are enunciated giving the relations between rates of exchange and purchasing power of money in different countries, excluding countries practising continuous inflation. The principles are verified by constructing curves of the purchasing power of the franc in England, the United States, Italy, and Spain, over a series of years.—A. **Buhl**: The secular movement of the perihelion of Mercury.—Rodolphe **Soreau**: The laws of variation with altitude, in the troposphere, of the characteristics of standard air.—Henri **Fabre**: Hovering flight in the Mediterranean. The flight of a bird (probably the puffin) has been studied; it rarely flies in calm weather, and when forced to do so its flight resembles that of a duck. But as soon as the wind velocity and height of the waves reach certain definite values, the bird flies with motionless wings. The explanation of this flight is based on the hypothesis that vertical air-currents are produced by the wind striking the waves. There must be both ascending and descending air-currents, but the bird utilises only those ascending currents the direction of which is controlled by the direction of the crests of the waves.—W. D. **MacMillan**: Can the mean density of the Universe be finite?—Emile **Borel**: Remarks on the preceding communication.—Ch. **Maurain** and Mme. **de Madinhac**: Evaluation of the intensity of the vertical electric currents traversing the soil in France.—R. **Boulouch**: The aplanatic telescope.—R. **Jouaust**: The application of pyrometers to high frequency measurements. The Féry pyrometer can be utilised in some measurements necessary in radiotelegraphic installations. Two examples are given, the calibration of high frequency ammeters and the measurement under working conditions of the resistance of the oscillating circuit of a lamp generating station.—L. **Gaumont**: A new sound amplifier. The vibrating part of this apparatus consists of a silk cone on which is coiled a spiral of fine aluminium wire; the cone is fitted between the poles of an electromagnet, similarly shaped. The telephone currents pass round the spiral wire on the cone, which is set in vibration by the action of the magnetic field. The sound is magnified without distortion, and one apparatus had a range of hearing of 300 metres.—P. **Lemay** and L. **Jaloustre**: Some microbiological consequences of the oxidising properties of thorium-X. Earlier researches showed that the radioactive elements behave as oxidising catalysts. This suggested that thorium-X should favour the growth of aerobic organisms and slow down the development of anaerobic organisms. Experimental proof of the correctness of this view has been obtained, using *B. lacticus* and *B. butyricus* as the test organisms.—P. **Loisel** and **Michaïlesco**: The radioactivity of the springs of the Baths of Hercules in Roumania. The waters from four of seven springs examined show marked radioactivity, in amounts varying with date of collection.—Léon **Guillet** and Marcel **Ballay**: The vapour-pressure of some copper-zinc alloys in the solid state. The vapour pressure of zinc in brass (zinc 44·8 per cent.) varied between 3·0 mm. at 535° C. and 19·32 mm. at 630° C. In the presence of air, the loss of zinc was smaller than in nitrogen, hydrogen, or carbon monoxide.—MM. **Dervin** and **Olmer**: Ammoniacal silver fluoride. This compound has the composition $AgF . 2NH_3 . 2H_2O$. On careful heating it loses water, ammonia, and ammonium fluoride, leaving an explosive nitride, Ag_3N.—J. **Valentin**: The solidification of the system $MgCl_2 . KCl . BaCl_2$.—Paul **Pascal**: Magnetic analysis of the stannic acids. Measurements of the magnetic susceptibility of stannic oxide in various states of hydration give no evidence of the formation of any definite stannic acids.—F. W. **Klingstedt**: The ultraviolet absorption spectra of toluene and the xylenes. The three xylenes possess very different absorption spectra.—Louis **Grenet**: A possible modification of the iron-cementite diagram.—L. J. **Simon**: The influence of the structure of organic compounds on their oxidation by chromic and sulphuric acids. The combustion of organic compounds by the chromic-sulphuric acid mixture is not always complete, and from the data given, there would appear to be a relation between the amount of carbon escaping combustion and the molecular structure of the compound.—André **Brochet**: Some properties of the active nickel employed as catalyst in organic chemistry.—Marcel **Delépine**: The iridio-dipyridino-tetrachlorides $M[Ir(C_5H_5N)_2Cl_4]$.—M. **Faillebin**: The hydrogenation of aldehydes and ketones in the presence of pure and impure platinum black. The reduction of aldehydes and ketones to the corresponding alcohols by hydrogen with pure platinum black as a catalyst gives bad yields: there is a tendency for the formation of hydrocarbons, and the catalyst becomes rapidly fatigued. If the platinum black is made from a solution of chlorplatinic acid containing ferric chloride, the impure catalyst gives excellent yields of alcohols.—G. **Delépine** and V. **Milon**: The presence of Waulsortian reefs in the carboniferous limestone of the Laval basin.—L. **Barrabé**: The presence of transferred strata in the eastern Corbières.—F. **Roman**: The quaternary terraces of the upper valley of the Tagus. —Albert **Nodon**: Researches on solar action at a distance.—V. **Schaffers**: Lightning and trees.—E. **Roger**: The periodic return of severe winters. In 1860 Renou noted that severe winters recur periodically. The author gives additional data in support of this, and puts the period as 41 years.—E. **Fichot**: The constitution of oceanic areas in basins of resonance, originating from continental masses under the action of the tides.—G. **Hamel**: Some peculiarities

of the algologic flora of Saint Malo.—P. **Mazé**: The practical conditions for using calcium cyanamide as a manure. The best way to apply calcium cyanamide to the soil is to mix it with peat.—Ch. **Brioux**: The comparative assimilability of calcium phosphate and the phosphates of iron and alumina. Plants can assimilate phosphorus from the phosphates of aluminium and iron, and from the experiments described the facility of assimilation of phosphorus from the phosphates of aluminium, calcium, and iron is in the order given. From this it follows that in determining the useful phosphorus in manures the solvent employed should attack not only the phosphates of the alkalies, lime and magnesia, but also phosphates of iron and alumina.—A. **Pézard** and F. **Caridroit**: The action of the testicular hormone on the relative valency of the allelomorphic factors in sheep (Dorset and Suffolk).—H. **Barthélemy**: Maturation *in vitro* and activation of the eggs in the general cavity and conduits in *Rana fusca*.—Paul **Portier** and Marcel **Duval**: Osmotic pressure of the blood of the "wiped" eel as a function of modifications of the salinity of the external medium. The mucus abundantly secreted at the surface of the skin of the eel has a marked influence on the isolation of the internal medium. The partial or complete removal (by wiping the surface) of this protective medium causes an increase in the osmotic pressure of the blood serum when the salinity of the external medium is increased.—Ed. **Le Danois**: The prediction of the value of the herring catch in winter. The prediction is based on the study of the 14° C. isotherm at 50 metres depth in August, and the assumption that the movements of the herring are governed by the temperature of the water. The fishing results this winter have confirmed this view.—Louis **Roule**: The ecology of the sturgeon (*Acipenser sturio*) in the Atlantic regions of France.—H. **Hérissey**: The biochemical synthesis of *d-a*-mannoside starting from mannanes.—Emile F. **Terroine**, E. **Brenckmann**, and A. **Feuerbach**: The identity of composition of organisms of the same species after death by starvation.—G. **Marinesco**: The rôle of oxidising ferments in the production of fevers and inflammations.

BRUSSELS.

Royal Academy of Sciences, October 14.—M. A. Lameere in the chair.—C. **Cesàro**: The blue crystals of disthene found at Katanga. Facility of the g_1 cleavage. The angle of extinction on g_1 and in the other faces of the vertical zone. Corresponding faces. The results of a detailed crystallographic examination of small crystals of disthene, collected in Katanga sands. The same sand contained a single crystal of euclase, a mineral not hitherto found in the Congo.—Leon **Fredericq**: New Belgium. The colony of arctic-alpine animals and plants found on the Baraque Michel plateau is exceptional and is not found to the same extent on the other high plateaux of New Belgium, notably at Losheimergraben. This phenomenon appears to be connected with the local anomaly of temperature which characterises the climate of the Baraque Michel.—Maurice **Nuyens**: The trajectory of an electrified point in the field due to an electron.—H. **Buttenbach**: Note on kasolite. The results of a crystallographic examination of kasolite, found along with pitchblende in the Katanga copper mines.—Charles **Fraipont**: Observations on the large Pleistocene Felidæ.

November 4.—J. **Neuberg**: Geometry and mechanics.—N. **Saltykow**: The development of the theory of partial equations of the first order of a single unknown function.—Paul **Brien**: Researches on the embryogeny of *Salpa maxima*.

SYDNEY.

Linnean Society of New South Wales, October 25.—Mr. G. A. Waterhouse, president, in the chair.—R. J. **Tillyard**: Mesozoic insects of Queensland. No. 9. In the Protorthoptera a large number of fragments of the peculiar *Mesorthopteron locustoides* Till. enables a full restoration of the wing to be made. Two new genera and species are described in the Orthoptera, one related to mantids, the other a very elongated locustoid type. In the Odonata a practically complete wing of an Archizygopteron forming the type of a new family is discussed. In the Hemiptera a large number of new types are dealt with, including the first Triassic record of representatives of the Cryptocerata or water-bugs, and several new Homoptera belonging to the Scytinopteridæ, Tropiduchidæ, Cixiidæ, and Ipsviciidæ.—A. J. **Turner**: Some Australian moths from Lord Howe Island. Ship traffic plays an important part in the introduction of Australian species of Lepidoptera into Lord Howe Is., Norfolk Is., and New Zealand.—Vera **Irwin-Smith**: Notes on nematodes of the genus Physaloptera. Pt. iv. The Physaloptera of Australian Lizards (contd.). Two new species and a larva found encysted in the body cavity of *Hinulia tæniolatum* are described. The cyst-forming habit was not known before in the genus, and Physaloptera have never been recorded, hitherto, outside the alimentary canal.—G. D. **Osborne**: The geology and petrography of the Clarencetown-Paterson district. Pt. ii. The larger faults are connected with the folding movements which produced asymmetric plunging folds as the outcome of thrusting due to the subsidence of the sub-oceanic segment of the Pacific. The age of the faulting and folding is probably post-Upper Marine and pre-Triassic. A comparison between the plan of the outcrop of the Bolwarra conglomerate in the Permian Series and that of the Paterson toscanite in the Kuttung Series gives evidence of differential crumpling of these two series.

Official Publications Received.

British Astronomical Association. Handbook for 1923. Pp. 38. (London: Eyre and Spottiswoode, Ltd.) 2*s*.

Dove Marine Laboratory, Cullercoats, Northumberland. Report for the Year ending June 30th, 1922. Edited by Prof. Alexander Meek. Pp. 105. (Cullercoats.) 5*s*.

Madras Fisheries Department. Bulletin No. 13: Administration Report, 1919–20, by the Hon. Mr. A. Y. G. Campbell; Remarks on Canning and Manufacture of Fish Oil and Guano, by Sir F. A. Nicholson. (Reports Nos. 1, 2 and 3 of 1921.) Pp. 266. (Madras: Government Press.) 3.2 rupees.

Diary of Societies.

THURSDAY, DECEMBER 28.

ANNUAL CONFERENCE OF EDUCATIONAL ASSOCIATIONS (at Bedford College for Women), at 3.—Sir Michael Sadler: Presidential Address.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. H. H. Turner: Six Steps up the Ladder to the Stars. (1) The Distance of the Stars. (Juvenile Lectures.)

FRIDAY, DECEMBER 29.

EUGENICS EDUCATION SOCIETY (at University College), at 3.

Y.M.C.A. (at University College), at 3.—Sir Arthur Yapp and others: The Y.M.C.A. and Adult Education.

NATIONAL LEAGUE FOR HEALTH, MATERNITY, AND CHILD WELFARE (at University College), at 5.30.—Dr. E. Pritchard: Physical Development and its Food Requirements.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—C. F. Morgan: Brewery Engineering.

SATURDAY, DECEMBER 30.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. H. H. Turner: Six Steps up the Ladder to the Stars. (2) The Discovery of the Planet Neptune. (Juvenile Lectures.)

SATURDAY, DECEMBER 30, 1922.

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The Development Commission.[1]

THE Development Commissioners have just issued a report on their operations during the year ended in March last. For a Blue-book it is an unusually interesting document, containing as it does many verbatim reports from Directors of Research who do not disdain, on occasion, the aid of the poets in describing their labours. We may instance Mr. W. B. Hardy on fishery research :

"The frontal attack," he says, "usually called, 'taking a practical view' of the problem, often fails, and rarely gives more than a partial and incomplete solution.

"Scientific history shows that the solution of a problem more often than not comes from a direction totally unexpected—

"'For while the tired waves, vainly breaking,
Seem here no painful inch to gain,
Far back, through creeks and inlets making,
Comes, silent, flooding in, the main.'"

And the corollary is well expressed :

"The search for the fundamentals of knowledge must remain the business of specialists trained to the use of the test tube and microscope. But it is one of the gravest fallacies responsible for the suspicion with which the 'practical' man often views science, which represents the work of the specialist as something different from that of the man engaged in the day-to-day employment of industry."

No man has a wider contact with research in its practical outcomes than has Mr. Hardy, and no one is entitled to speak with greater authority on the State organisation of research.

In the year under report the Development Commissioners recommended the expenditure of 368,450*l.*, of which 41,372*l.* was by way of loan. The grants to agriculture amounted to 226,253*l.* Under the head of fisheries the grants recommended totalled 71,218*l.* Fishery research workers appear to be in the happy position of explorers of a new and rich country, and the Commissioners were well advised in devoting a large section of their report to a detailed review of the progress made in the solution of fishery problems. As the British sea fisheries alone provide about 13 million tons of fish annually, it is clear that even the wide seas about our coasts cannot continue to furnish such a quantity unless the increased control which increased knowledge alone will bring comes to the rescue. Of this knowledge and the need for its extension, here is an example :

"The study of the edible crab," says Mr. Hardy, "now in progress at Aberdeen, has revealed the fact that there is a steady migration from the East Coast to the Moray Firth. One marked crab was found to

[1] Twelfth Report of the Development Commissioners for the year ended March 31, 1922. H.M. Stationery Office. 3*s.* 6*d.*

have covered over 100 miles of coast in just about as many days. All the lines of migration meet at a point in the Moray Firth. Why? We do not know, but it is something gained to have established the fact of the migration."

Another interesting discovery is a method of purifying mussels (and, probably, oysters too) by treating them with chlorinated water and thereby inducing them to cleanse themselves of sewage bacteria. Researches in plankton are proceeding vigorously at many research stations. This, of course, provides the most fundamental problem of all. Just as the harvest of the land depends, ultimately, on the activities of certain microscopic organisms in the soil, so the harvest of the sea depends, in the long run, on the microscopic organisms it contains. It is interesting to learn that, equally with the soil workers, fishery investigators are giving much attention to hydrogen ion concentration. In sea water, this measure of acidity appears to be correlated with the content of organic matter. Perhaps the most important fishery problem is connected with the herring. The mysterious movements of this fish, affecting as they do the livelihood of thousands of persons, have been celebrated in song and story. Shoals may suddenly desert waters which they have frequented for centuries. The Hanseatic League (a German domination of England) was terminated in the fifteenth century largely by the failure of the herring fishery in the Baltic; within living memory, the herring has deserted Loch Fyne in Scotland. As the Scottish song, "Caller Herrin'" runs:

"You may ca' them vulgar farin',
Wives and mithers, maist despairin',
Ca' them lives o' men."

The problem is as yet unsolved, but it is the business —and the certain hope—of science to solve it.

Of the many forms of State organisation of research, that under which fishery investigations are regulated appears to be one of the best. In outline there is provision for (1) "free" and (2) "directed" research. The latter is devoted to the solution of definite economic problems, whereas the former is concerned with the study of fundamental problems which lie at the root of any advance in the practical sphere. But no attempt has been made to lay down a definite border line. Controlling both there is an Advisory Committee of scientific men, the advice of which the Commissioners appear to accept unhesitatingly.

We notice that the various Agricultural Research Institutes continue to produce much valuable work, though the section of the report devoted to agricultural research does not include much new matter of interest.

The report does not contain, as in the past, an account of the present finances of the Fund. In an article published in NATURE for April 8 (vol. 109, p. 433) some apprehension was expressed on the score of the low ebb which last year's report showed the Fund had reached. Having survived the attack of the Geddes Committees, it would be indeed unfortunate if the future of fishery research should prove to be still uncertain, while it is equally necessary that the valuable researches of such institutions as the Plant Breeding Stations should be continued and placed on a permanent basis.

The Petroleum Industry.

The Petroleum and Allied Industries: Petroleum, Natural Gas, Natural Waxes, Asphalts and Allied Substances, and Shale Oils. By James Kewley. (The Industrial Chemistry Series.) Pp. xi+302. (London: Baillière, Tindall, and Cox, 1922.) 12*s*. 6*d*. net.

THE literature concerned with petroleum and its products is becoming almost as extensive as that which relates to coal. But whereas that of coal is the growth of some centuries, the literature of petroleum has been accumulated within living memory. This is due, of course, to the extraordinary development of the use of petroleum as a source of light and heat. The growth of motor transport has been remarkable, due in no small measure to the influence of the Great War, directly and indirectly. Aviation has arisen wholly within our own time, and is one of the most striking of the new departures which the twentieth century has witnessed. The exploitation of our oil-fields has become a question of national importance, and, it may be added, of international difficulty. The growth in the use of petroleum is well illustrated by the subjoined table, taken from the recently published Report of Lloyd's Register of Shipping for the year 1921–1922, showing the progressive demand for oil-carrying vessels:

	Oil-tankers.	
July 1914	1,478,988	gross tons.
July 1919	2,929,113	,,
July 1920	3,354,314	,,
July 1921	4,418,688	,,
July 1922	5,062,699	,,

It is further shown by the increase in gross tonnage of vessels either originally fitted to burn oil fuel or subsequently converted for that purpose:

	Vessels fitted for burning oil fuel.	
July 1914	1,310,209	gross tons.
July 1919	5,336,678	,,
July 1920	9,359,334	,,
July 1921	12,796,635	,,
July 1922	14,464,162	,,

Additional evidence is furnished by the large increase

in the number of motor vessels during the same interval:

	Motor Vessels. Number.	Gross tons.
July 1914	297	234,287
July 1919	912	752,606
July 1920	1178	955,810
July 1921	1473	1,248,800
July 1922	1620	1,542,160

These statistics, it must be understood, are those recorded in the Register books of the society, and are probably an underestimate of the growth which has actually occurred throughout the world. They are, nevertheless, highly significant and instructive, and serve to illustrate what is a great factor in world-wide progress, and eminently characteristic of our own age.

The book under review may be recommended as a concise and well-informed account of the rise and growth of this important industry. It is well arranged and well written, and considering its limitation as to space, deals in sufficient detail with its more important phases. It is divided into nine main sections, or parts, each of which is further subdivided into several subsections. The classification is rational, and conduces to a logical treatment of the subject-matter.

Part I. is introductory, and treats of the terminology of petroleum products and of the history of the petroleum industry; of the chemistry, geology, and mode of origin of natural petroleum. Part II. is concerned with natural gas, its occurrence, distribution, composition, and applications. Part III. treats of crude petroleum, its occurrence, distribution, and character; of drilling and mining operations, and of the storage and transport of crude oil and its liquid products. Part IV. describes the manufacture of shale oils and of the various tars obtained as by-products. Part V. deals with asphalts. Part VI. with the natural mineral waxes. Part VII. with the working up of crude oils, their distillation, fractionation, and chemical treatment; the manufacture of paraffin wax and lubricating oil; "cracking" and hydrogenation processes; and refinery waste products. Part VIII. describes the characters and uses of petroleum products, and Part IX. gives some account of the methods of testing and standardising them.

As regards the origin of petroleum, in spite of much discussion and the voluminous literature to which the subject has given rise, we know nothing with certainty. The volcanic or inorganic theory, although advocated by such authorities as Humboldt, Berthelot, and Mendeléeff, is inconclusive, and there is an increasing body of evidence against it. On the other hand there are many objections to the assumption that petroleum has been produced from organic remains, although the geological evidence, at least in the case of certain oil-bearing districts, lends a certain measure of support to it. The question is fairly discussed by the author in the light of the most recent contributions to it, and, on the whole, he is inclined to consider that the majority of crude oils are probably of vegetable origin, although he advances no surmise as to the mechanism of their formation.

One of the most important developments connected with the petroleum industry is the utilisation of the natural gas which is evolved in enormous quantities in certain oil-bearing regions. This utilisation has mainly occurred on the American continent owing to the circumstance that certain of the oil wells are not too remote from centres of population. Many towns in America are supplied with this gas at a very low cost. Much of the gas is consumed in the manufacture of so-called carbon-black, an extremely fine form of soot far superior to ordinary lamp black as a pigment and for the manufacture of printing-ink. It is calculated that one pound of carbon black suffices to print 2250 copies of a sixteen-page newspaper. Upwards of fifty million pounds of this material were produced in the United States in 1920, from thirty-nine operating plants in various States, mainly in West Virginia and Louisiana. Considerable quantities are used in the rubber tyre industry, for the manufacture of stove polishes, Chinese and Indian ink, paper manufacture, tarpaulins, etc. But even when the gas cannot be immediately utilised it is now liquefied and stored under pressure by modern compression and refrigerating plant, and can be transported.

Mr. Kewley is to be congratulated on the production of a valuable contribution to the literature of an industry which is pre-eminently characteristic of our own epoch.

Unified Human History.

A Short History of the World. By H. G. Wells. Pp. xvi+432. (London: Cassell and Co., Ltd., 1922.) 15*s*. net.

THIS is a new work covering the same ground as the "Outline of History" and in the same spirit, but re-written and better written, and correcting many of the faults of judgment and proportion which disfigured the earlier book. Mr. Wells has digested his material in the interval and writes now with ease and mastery. The arrangement and general division of the space is quite satisfactory, and the production and illustrations are excellent. It is a great feat, following so quickly on the labours of the "Outline," and all who are interested either in history, in education or in the social progress of the world as a whole, are under a deep debt of gratitude to Mr. Wells for carrying it out. Nothing has done so much to awaken the public to the social importance of history, and the readers of history to the unity of their subject. The books are a prodigy of industry and skill and in the realm of literature the

best thing we owe to the war. It was at a gathering of thinkers and social workers during the war that the idea of teaching world-history to all nations on a common plan was first mooted, and Mr. Wells responded to the appeal. His "Outline" has sold in hundreds of thousands, especially in the United States. It has provoked demands among working men to be taught history in that spirit; it has changed the outlook and the syllabuses of scores of teachers; it has helped to success other similar books such as the fascinating "Story of Mankind" by Van Loon, which has come over to us from America this autumn.

In view of all this, it is paltry and unworthy to dwell on minor defects or on differences of judgments, and still worse to condemn Mr. Wells because not being a "historian," he has done a work which "historians" ought to have done over and over again before.

It was probably this fact, that he was not a historian in that sense, immersed in the details of some special period or aspect of history, which, added to his own incomparable powers of reception, production, and imagination, enabled Mr. Wells to accomplish the feat. The freshness of his mind prompts him constantly to some interesting new view, some comparison especially of ancient and modern times, some wholesome challenge to accepted judgments; *e.g.* "It was not so much the Jews that made the Bible, as the Bible that made the Jews." "How important a century this sixth B.C. was in the history of humanity. For not only were these Greek philosophers beginning the research for clear ideas about the universe and man's place in it, and Isaiah carrying Jewish prophecy to its sublimest levels, but, as we shall tell later, Gautama Buddha was then teaching in India and Confucius and Lao Tse in China. From Athens to the Pacific the human mind was astir."

Even in the case of Rome, to which Mr. Wells still does less than justice, it is enlightening to have the comparison with our modern empire. "The Roman empire after all was a very primitive organisation; it did not educate, did not explain itself to its increasing multitudes of citizens, did not invite their co-operation in its decisions. There was no network of schools to ensure a common understanding, no distribution of news to sustain collective activity."

All such comparisons, whether of contemporary happenings or of earlier and later social states, are useful and inspiring and arise from the synoptic frame of mind which qualifies a man for such work as this. It is an antidote to the excessive criticism and tendency to pessimism which mark so much of our literature at the present time. But it needs to be based on a sound knowledge and appreciation of the historical fact, and it is naturally on this latter side that Mr. Wells is weaker. He does not estimate duly what Rome did for the world, the greatness of her legal work, its continued progress, its permanence in the modern world. Nor does he allow for the constructive value of the medieval Church and Catholic doctrine. No word of Dante (or of Descartes) with a whole chapter for Charles V.! That is a blemish impossible to pass over. It goes with a general tendency in the book to lay stress rather on the externals and the picturesque figures in history than on the deeper, spiritual, or intellectual factors. Thus Archimedes and Hero appear but not Pythagoras, Stephenson and Watt but not Descartes and Leibniz, or even Newton. Science appears as the transformer of industry, the generator of steam-engines and steamships, but not as the knitter-up of men's minds, the new universal doctrine which replaces theological dogma. Even science as the healer and preventer of disease seems to find no place: there is no word of Hippocrates or Pasteur.

We know well how easy it is in reviewing such a book to draw up lists of inexcusable omissions. It would be ungrateful in this case, for Mr. Wells has given us so useful and attractive a gift and has worked so valiantly for the cause both of history and of science, and especially of science as coming into and modifying history. His answer, no doubt, to the last criticism would be that this was an introductory volume, and that therefore he avoided such matters as philosophy. But can one properly treat of religion without philosophy? And there are sympathetic chapters about Christ and Buddha. It would help his general cause, which is the salvation of mankind by education and unity, to lay more stress on the spiritual or intellectually constructive aspect of science and less on its mechanical applications. It is not the difficulties of posts and tariffs which will ultimately bring mankind together in harmonious progress: it will be a spiritual union of which knowledge and sympathy, science and law are co-operating factors, and may be traced growing, sometimes fitfully, and at various times and places, but never quite extinguished from the beginning of history till now. These should be the leading threads in any short sketch of human history as a whole, and it is because of their decisive contributions to those elements that Greece, Rome, Christianity, and modern times deserve a special place.

F. S. MARVIN.

Naturalisation of Animals and Plants.

The Naturalisation of Animals and Plants in New Zealand. By the Hon. George M. Thomson. Pp. x + 607. (Cambridge: At the University Press, 1922.) 42*s*. net.

FROM those early days in the neolithic age when the nomad tribesman drove his domestic stock from the region of its creation to new areas, naturalisa-

tion of plants and animals has been a fact to be reckoned with in the evolution of faunas and of humanity. Even in countries where the introduced creatures belonged to groups identical with, or closely related to, members of the indigenous fauna, and where, on that account, a simple speeding-up of a process already in force might have been expected, the influence of naturalisation on fauna and flora has been profound. It is easy to imagine how much more intense that influence might be in countries where the new-comers belonged to orders of animal and plant life unrepresented in the native fauna and flora, and entered a free field unhampered by the checks which, in the course of ages, had created in the old country a tolerably stable balance of Nature. It is this unusual mingling of the faunas of distinct and widely different zoo-geographical regions that gives special significance to the events in Australia and New Zealand, and has made the attempts of the settlers there a by-word in the history of acclimatisation.

Another special interest attaches to these areas, however, and adds enormously to the value of this book. In the old countries, lying in the way of the migrations of palæolithic and neolithic man and his successors, introductions of plants and animals have taken place from time immemorial, with the result that, since the beginnings are lost to view, results can be only dimly envisaged; but in New Zealand, apart from a few prehistoric Polynesian introductions, almost every beginning has a date, and almost every stage of progress can be measured in terms of years.

Mr. Thomson has dealt with the unique opportunity that lay to his hand in the scientific spirit; he has been chary of broad generalisations, and he has been at endless pains to collect and verify information, much of which in a few years would otherwise have slipped from ken. Consequently his work must be regarded as a standard contribution to the history of acclimatisation.

The plan of the book is of the simplest: after a short introduction and historical review, it proceeds to consider each animal and plant introduced to New Zealand, whether or not it has become established, in its order in systematic classification. (The author has overlooked the fact that all his rodents are grouped under the heading "Carnivora.") The mass of material handled can be only roughly gauged by the fact that of mammals and birds alone, 48 of the former have been introduced, of which 25 have become truly feral, and of the latter, 24 out of 150 introduced species are now thoroughly established; while of plants, more than *six hundred species* have become "more or less truly wild."

It is impossible here to follow Mr. Thomson's catalogue of events; even the familiar stories of the ill-starred introductions of the rabbit and its enemies, and of the introduction of humble-bees to fertilise the introduced red clover, are filled with new and significant detail; but let us turn to some of the broad results of this century and a half's intense interference with Nature.

Great expectations were formed of the probability of seeing the development of new variations and of incipient new species; but fifty years of close observation lead the author to state that he is "aware of no definite permanent change in any introduced species" (p. 513). The statement does not exhaust the possibilities, however; first, because the time is short—the first animals were introduced in 1773, and most have been in the country for scarcely more than half a century; secondly, because changes are noticeable—red deer introduced from Forfarshire only fifty years ago, now carry, instead of a former limit of 12, up to 20 points on their antlers; and, thirdly, because the progeny of introduced animals has not been submitted to that minute examination and comparison of cranial and other characters on which racial distinctions are now based. Again, Darwin and Wallace both expected that the wholesale naturalisation of European plants would ultimately exterminate part of the native flora. The author sees no evidence of such a process: "The native vegetation can always hold its own against the introduced" (p. 528); "the struggle . . . will result in a limitation of the range of the native species rather than in their actual extermination" (p. 533). But is the conclusion not doubtful, or at any rate premature? In long-civilised countries, for example, Scotland, it has been shown that there are no bounds to the cumulative effect of man's influence, and that limitation of range is too often but a first step to ultimate, even if long-delayed, extinction.

Yet many changes have been observed. Introduced trout established new records in size, water-cress grew to a length of twelve to fourteen feet, "with stems as thick as a man's wrist," the common spear thistle formed thickets six to seven feet in height; even since 1868 nine species of birds have disappeared to a great extent or altogether, and many have been driven to the wildernesses; several species of fish have been exterminated by established introductions; habits have changed—many species have adopted introduced food plants, the Kea parrot supplements its fruit diet with the flesh of living sheep. On the whole, the introductions have done much more harm than good. Of all the birds introduced, the only one against which no complaint has ever been made is the hedge sparrow; but there must often be difficulty in assessing the balance of good and evil. In one place we are told

that "the evidence regarding the destruction of the native avifauna by stoats and weasels is very inconclusive" (p. 73), and in another that "these animals [weasels and other vermin] are largely responsible for the decrease in the numbers of native birds" (p. 89).

One conclusion, however, is manifest, that neither in New Zealand nor elsewhere should naturalisation of exotic animals be permitted, except with the consent of a properly constituted advisory committee containing a strong representation of biological science. Perhaps we can afford to smile at the enthusiasm of men who endeavoured to establish migratory birds, or brought from Britain the humble-bee, *Bombus terrestris* (now the commonest species in New Zealand), to fertilise the red clover, not knowing that its trunk was too short to reach the bottom of the clover flower; but we should not be subject to the vagaries of such as the New Zealand legislator who, when it was proposed to introduce half a dozen Venetian gondolas, to be placed on a lake in the public gardens of Nelson, protested against the extravagance and desired to import only a pair, "and then let Nature take its course."

JAMES RITCHIE.

Boscovich and Modern Science.

A Theory of Natural Philosophy. Put forward and explained by Roger Joseph Boscovich. Latin-English edition. From the Text of the First Venetian edition published under the personal superintendence of the Author in 1763. With a short Life of Boscovich. Pp. xix+470. (Chicago and London: Open Court Publishing Co., 1922.) 63*s*. net.

IN the time of Boscovich the line of demarcation between the philosopher and the physicist or mathematician was much less clearly marked than it is to-day—perhaps it is better to say than it was a few years ago. It is therefore to be expected of a man of Boscovich's energy and versatility, living in the eighteenth century, that he should have explored the borderland of philosophy and science. The book before us contains the contribution of Boscovich to this domain—for us the most important work of his life. In it he appears to a modern as a philosopher rather than a man of science, interested largely in the search for and use of *a priori* arguments, but in close touch with the scientific theories and explanations of his day.

Whether this classification is right or wrong, the book is full of interest. Boscovich is sometimes claimed as the father of modern atomic theory, and this volume provides at any rate partial justification for the claim. For Boscovich shows with admirable clearness how many diverse phenomena in mechanics and even in other branches of physics can be explained in a natural qualitative way on his hypothesis that matter consists of discrete points accelerated towards each other by a perfect definite law of suitable form. But from the modern point of view his work in this connexion is scarcely more interesting than the earlier work of Daniel Bernoulli, or the still earlier ideas of Hooke. To a mathematician perhaps the most interesting sections of the book are those in which Boscovich expounds the law of continuity, the doctrine of impenetrability, and their consequences. It is at once evident that his ideas of the properties of a continuum and of a progression, though of course not extensive, are invariably clear and accurate.

Other interesting passages are those in which Boscovich makes use of proofs by induction or criticises the inductive reasoning of others—for example, attempts to establish thus that matter must have continuous extension. He is always careful to explain why he believes his own inductive arguments to be valid when he makes them. In fact one may strongly suspect that his first instinct in all such cases is to take up a sound sceptical point of view, with perhaps a slight weakness for his own favourites. In this he is by no means unique, and in full agreement with a certain distinguished man of science of to-day who is reported to have defined scientific truth in conversation with a friend as "the theories which you and I believe, and I include you for courtesy."

Boscovich is firmly convinced of the underlying simplicity of all natural phenomena. The main thesis of his book is to show that it is conceivable that all the properties of matter might be explainable on the basis of his unique acceleration law. In a delightful passage (pp. 105-7) he attacks the multiplicity of forces used by the physicists of his day and the danger of concluding that Nature is complicated when it may only be that the mathematics is inadequate.

Both as a final example of the depth and range of his ideas and for its latter-day interest we must quote the following passage, in which he is discussing the form of his acceleration law. He has just assumed that the mutual acceleration of two of his points is always bounded except when the distance between them actually tends to zero. He proceeds: "In this case it is evident that, if a sufficiently great velocity can be given to any mass, it would pass through any other mass without any perturbation of its own parts, or of the parts of the other. For the forces have no continuous time in which to act and produce any finite sensible motion; since if this time is diminished immensely . . . the effect of the forces is also diminished immensely. We can illustrate the idea by the example of an iron ball, which is required to pass

across a plane, in which lie scattered in all positions a great number of magnetic masses possessed of considerable force. If the ball is not projected with a certain very great velocity . . . its motion will be checked by their attractions. But if the velocity is great enough, so that the actions of the magnetic forces only last for a sufficiently short interval of time, then it will certainly get through and beyond them, without suffering any sensible loss of velocity." Further evidence of his clarity of thought need scarcely be given.

In conclusion let us admit the great debt of gratitude which we owe for the production of this book to the translator, Mr. J. M. Child, and to the Government of the Kingdom of Serbs, Croats, and Slovenes who generously financed its publication.

Our Bookshelf.

Chelsea Porcelain. By William King. Pp. xv+135 +70 plates. (London: Benn Bros., Ltd., 1922.) 73*s.* 6*d.* net.

It seems appropriate that this elaborate and sumptuously illustrated volume should proceed from an official of the ceramic department of the Victoria and Albert Museum, where an extensive and thoroughly representative collection of Chelsea porcelain is permanently displayed for the delectation of the public. Such a handbook of one section of the treasures housed in the museum, setting forth the story of their manufacture and the reasons or sentiments which inspired the decorations they bear, should bring many fresh visitors to the collections. It should stimulate the interest which each succeeding generation manifests in the doings of the potters and porcelain-makers of a past age, for they have proved themselves the unconscious historians of its social customs. It is impossible for any one, however limited his purview, to linger among these brilliant and fascinating objects without feeling a desire to know more of their history and how they came to be decorated as they are. Even to those who know little of historic styles in decorative art it must be obvious that whatever is native and English in these porcelains is interwoven with motives caught from the work of other countries than ours, Oriental as well as European, so that they provide even a casual observer with endless food for thought and research.

To-day, after a century and a half of change, it stirs our blood to examine such masterpieces of patient skill and elaboration, wrought in a beautiful but difficult material with an insufficient regard to time and cost, when an English factory tried conclusions with the state-aided establishments of Europe and won a well-deserved reputation for its courage and skill.

The gradual development of the Chelsea enterprise from its modest beginnings to the heyday of its success is traced with a wealth of detail drawn from the patient labours of many previous investigators, but its story is enriched by the knowledge which is only to be acquired from the constant handling and critical examination of fine and authentic examples; so that, for many a long day, this volume is likely to remain a standard authority on its subject.

The numerous illustrations are remarkable for their variety and excellence. They cover the whole field of the porcelains made at the Chelsea factory, and, whether in colour or in half-tone, convey an excellent idea of the range and quality of the productions of that famous factory.

William Burton.

Blood Transfusion. By Dr. Geoffrey Keynes. (Oxford Medical Publications.) Pp. vii+166. (London: Henry Frowde and Hodder and Stoughton, 1922.) 8*s.* 6*d.* net.

The transference of blood from healthy persons to make up for deficiencies of quantity or quality in the sick has been proposed and occasionally practised for 300 years or more, but it is only within the last decade, and especially since the experience of the war, that this valuable therapeutic procedure has been put on a firm foundation and has come into common use. Dr. Keynes gives here an admirable account of our present knowledge of the theory and practice of transfusion. There is a most interesting historical account of the work of the pioneers, and it is curious to note that Higginson, in the middle of the nineteenth century, invented and used his syringe for this rather than its present purpose. The selection of blood donors is fully considered and a good description given of the different "blood groups" found in human beings—a topic of much wider importance than its immediate application to human therapy. In technique, the author's experience has led him to prefer the method of withdrawing the blood into a solution of sodium citrate to prevent clotting and then injecting a known amount at leisure into the recipient: anastomosis of the blood vessels of the two parties is difficult and uncertain.

In practice, the main usefulness of transfusion has been found in cases of hæmorrhage and shock, in which, as might be expected, blood has proved of more value than salt solution or Bayliss's gum. It has given good, if generally transitory, results in pernicious anæmia and a few cases of severe bacterial infections, but there is no very clear evidence of its utility unless the patient has the definite indication of too small a blood volume or too little hæmoglobin.

There is a bibliography of more than 300 items and a good index. Complete as is the account from the point of view of the practical surgeon, some further consideration of the experimental work of Worm Müller and his successors would have been welcome. There is, too, no adequate discussion of what happens to the red cells in their new home, how long they last, and how they are destroyed.

A. E. B.

The Voice Beautiful in Speech and Song: A Consideration of the Capabilities of the Vocal Cords and their Work in the Art of Tone Production. By Ernest G. White. Third edition. Pp. viii+166. (London: J. M. Dent and Sons, Ltd., 1922.) 7*s.* 6*d.* net.

The author's devastating thesis, that the human voice is *produced* by the frontal sinuses and other cavities in the bones of the head, while "the vocal cords," which he regards as strings, "are not the seat of sound," is not supported by a particle of evidence. That so

misleading a book should not only find a publisher but also reach a third edition, is disquieting. A teacher should be teachable, and the serious student of phonation will find sound information as to the parts played by the sinuses and the glottal lips in the production of vocal tone in Musehold's "Akustik und Mechanik des menschlichen Stimmorgans," 1913, which gives excellent laryngo-stroboscopic photographs of the miscalled "vocal cords" in action, confirming and supplementing Manuel Garcia's famous communication to the Royal Society in 1855 on the differing laryngeal mechanism for chest and falsetto registers. The kinematograph might do good service here.

The exhibition of a slow-motion film, such as that prepared by Prof. Panconcelli-Calzia and Dr. Hegener, of Hamburg, showing the lips of the glottis producing a definite note of chest register by periodically parting and meeting, parting and meeting, letting out as many tiny puffs of compressed air per second as there are double vibrations in the note sung (quite in agreement with what R. Willis, of Cambridge, wrote in 1828), and finally opening very wide for the singer to draw breath, would give in one minute a clearer idea of their double-reed action than pages of careful description may convey. Few misnomers, surely, have wrought so much pseudo-scientific havoc as Ferrein's *chordæ vocales* (1741). W. P.

An Introduction to Psychology. By S. S. Brierley. Pp. viii+152. (London: Methuen and Co., Ltd., 1921.) 5*s*. net.

UNLIKE many writers for non-professional students of psychology, the author of this work does not attempt to minimise the difficulty of the subject, nor does she seek to evade problematical conclusions by specious dogmatism. The book consists of two parts, the first dealing with the scope and method of psychology, and the second with some of the general problems of the subject. This latter part brings before the reader the fascinating but bewildering array of problems with which the modern psychologist is confronted. The reader is not left with the idea that having perused this book he knows everything about psychology, but he will feel that he has an excellent basis for continued study. The general plan is original, and while incorporating much of the work of such writers as James, McDougall, Freud, and Jung, yet it is much more than a mere compilation of the work of others. It will be of the greatest value not only to the beginner but also to any reader who wishes to get a clear survey of the state of psychology at the present time.

Physiology and Biochemistry in Modern Medicine. By Prof. J. J. R. MacLeod, assisted by Roy G. Pearce, A. C. Redfield, and N. B. Taylor, and by others. Fourth edition. Pp. xxxii+992. (London: H. Kimpton, 1922.) 42*s*. net.

THE first edition of this valuable text-book was reviewed at some length in NATURE of December 18, 1919 (vol. 104, p. 389), so that little remains to be said except to congratulate the author on the rapid appearance of successive editions. This fact is good evidence that the work fulfils a want. It will be remembered that it is especially directed to satisfy the requirements of the student and the practitioner of medicine, so that it is natural to find certain branches of physiology more fully discussed than others. It is perhaps open to question whether, for the class of reader contemplated, the common practice of treating such questions as osmotic pressure and the colloidal state apart from that of the physiological processes in which they play an important part, is to be recommended. Prof. MacLeod has kept the book well up-to-date, and it has received valuable improvements and additions since the appearance of the first edition in 1919.

The Conquest of the New Zealand Alps. By Samuel Turner. Pp. 291. (London: T. Fisher Unwin, Ltd., 1922.) 21*s*. net.

MR. TURNER is a mountaineer of varied experience extending over a quarter of a century. His latest book describes six seasons' climbing in the New Zealand Alps, including ascents of Mounts Cook and Tasman, the two summits of the group. It is mainly a climber's record of difficulties and triumphs, but incidentally it contains much description of the peculiarities of the New Zealand Alps and the ice conditions encountered there. On the whole, the climbs in most cases were not of exceptional difficulty, but there seems to be a tendency for the snow slopes to hang steeper than in most countries. This is due possibly to the nature of the rock, but more likely is the outcome of the snow falling frequently and at relatively high temperatures, which gives it greater binding power. The snowfall at low altitudes even in midsummer is an additional difficulty.

La Séparation Industrielle des Solides en Milieu Liquide. Par Prof. Léonce Fabre. Pp. v+227. (Paris: G. Doin, 1922.) 16 francs.

THE treatment of filtration from the point of view of chemical engineering forms the principal subject of this book. The various types of apparatus, including immersion and rotary filters, are fully dealt with, and the auxiliary apparatus, including pumps, thickeners, and classifiers, are also described, and methods of decantation are considered. The book is up-to-date, and the numerous illustrations add considerably to its interest and value: it is a most useful contribution to the literature of chemical engineering. As is usual in French books, the absence of an index takes away practically half the value of a work of this kind. This may seem a small point to the author, but English and American readers of technical books will consider it a very serious defect.

Seven Ages of Childhood. By Ella L. Cabot. Pp. xxxiv+321. (London: Kegan Paul and Co., Ltd., 1921). 12*s*. 6*d*. net.

MRS. CABOT divides the period from coming into the world to coming of age into seven sub-periods which she names the dependent age (0-3), the dramatic age (3-7), the angular age (7-11), the paradoxical age (12-14), the age of the gang or team (11-16), the age of romance (15-18), the age of problems (16-21). On all these she writes pleasantly and sympathetically. There may be little of striking originality in her pages; but there is a touch of serene wisdom which may perhaps be found more helpful.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

A Type of Ideal Electric Atoms.

THE *Philosophical Magazine* for December contains a long and interesting mathematical paper by R. Hargreaves, in which he explores possibilities of constructing self-subsisting orbital systems out of free massive positive ions combined with free negative electrons, held together by a rotation common to all. The solutions at which he arrives give a possible structure for an ideal atomic nucleus of the Rutherford type, namely, a revolving ring of alternate positive ions and negative electrons, with or without a positive ion at the centre or a number of ions lying along the central axis of the ring transverse to its plane. It is found that a limited number of structures of this type can subsist, stability requiring that the central charge shall be positive.

Analysis of the deformation of such a free ring by a field of electric or magnetic force yields striking results as regards the polarisations thereby produced, recalling cognate classical results obtained by Lord Kelvin and others long ago, relating to vortex rings in fluid. Around such a ring-nucleus outer electrons can describe orbits as satellites, either a few of them or many arranged in rings in the manner now familiar in illustrations of the outlying structure of atoms: their reactions on the ring-nucleus are analysed. So also are the reactions on the whole system of stray electrons or ions coming within its range from without, which may even combine with it in definite ways: interesting analogies to phenomena of ionisation and of emission of electrons come to light. The scale of magnitude of the system remains open to satisfy other conditions.

The author modestly disclaims authority to judge whether the properties he discovers have any substantial analogy with the radio-active and spectroscopic phenomena of actual atoms. But, apart from the mathematical interest, there can be no question that the result of such a systematic rigorous analysis of the dynamical behaviour of a definite group of free systems, proved to be possible and stable, is calculated to expand the range of ideas in this field of physical speculation, and so is well worth the labour it has entailed. The alternating arrangement of ions and electrons in the nuclear ring calls to mind recent theories in the very different domain of crystalline structure and conductance in metals, based on space-lattices in which metallic ions and electrons occur alternately. J. L.

Cambridge and the Royal Commission.

KINDLY permit me to reply to the criticisms in NATURE of November 25, p. 689, on my article in the *Quarterly Review*. (1) I note with satisfaction that my critic admits that "many of those who do not share [my] fears will agree with [me]" on the importance of having the proposed grants "charged on the Consolidated Fund." My fears arise from (*a*) the declaration made to the Commission by the Labour Party that the "control of the Universities merely by statute assisted by occasional Royal Commissions has now definitely failed and that something in the nature of a continuous administrative control by the State must be undertaken," and (*b*) from the imperious demand that this control should be exercised "by representatives of Trades Unions, Elementary School Teachers, Women's Organisations, County Councils, the Board of Education, etc." (Report, p. 72, *Q.R.*, pp. 350-351). Are my fears groundless in view of the fate which has befallen the Universities of France, Germany, and Holland, under State control?

(2) My critic tries to defend the proposal to hand over the control of all teaching and research to the Council, a political body, largely composed of men whose interests are in administration rather than in the advancement of knowledge, and seeks to justify this by the vague statement that "the electorate which chooses both bodies is the same," leaving out of sight the fact that the elections to the Council are almost wholly on very clearly defined party lines with little regard to educational questions. It is proposed to supersede the General Board of Studies (composed of representatives of the 14 Special Boards of Studies and 8 nominated by the Council chiefly from their own members) by a new Board of Studies and Research subordinate to the Council, to consist of 12: 6 appointed by the Council and 6 only by the whole body of University and College teachers. As the General Board has on it representatives of all the Special Boards the co-ordination of the various studies and a proper standard for the higher Doctorates can thus be, and is, well maintained. The bureaucrats hate the General Board because they cannot prevent the Special Boards from placing on it their leading men, no matter what their politics may be. The General Board is charged with being "unwieldy," and at the same time not wholly representative of all branches of study, and that "its co-ordinating functions seem to be impeded to some extent by the fact that it is largely composed of specialists." The animus shown against "specialists" gives the key.

My critic does not attempt to meet my statements that it is not "unwieldy" since it has the same number as the Oxford Council (23), that it does its work excellently, while the Council, when it interferes with education, deals badly with it and is slovenly in its routine business. If the General Board is "not wholly representative of all branches of study," then the new Board of 12 will be much less so, and the evil effects of such a Board are already felt in the new Board of Research set up by the Council to deal with applicants for the Ph.D.

(3) With regard to the disfranchisement of the Senate, my critic says that "In his criticism of detail Sir William Ridgeway is not happy. When he says 'The Cambridge Commissioners know perfectly well that it would not be easy to get fifty signatures to any appeal within a week,' the obvious answer is that Sir William Ridgeway knows perfectly well that in any issue of importance where an appeal to the Senate is likely, fifty signatures could be collected in the Senate-House from the defeated minority," etc. Here are my actual words: "It would not be easy to get fifty signatures to any appeal within a week, and to get those of one-third of the House of Residents within 14 days would be impossible in view of the further proposal that if a Grace passed by the House of Residents were rejected by the Senate, that Grace could be re-affirmed within two terms and become final." No one would think of getting up, or signing, an appeal to the Non-Residents to waste their time and money in coming to oppose a measure (nor if asked would they come) which even if defeated by the Senate would become law in two terms. As my critic has not dared to challenge any of my facts, his only resort was to impugn my honesty by garbling my statement, an attempt as futile as disingenuous. He repeats the charge that the control of the Senate is "capricious," because "its interven-

tion is made at the capricious decision of a body of resident conservatives who, through the Senate, wield a wholly disproportionate power on matters vitally affecting the well-being of the University." Yet he had just admitted that only thrice in twenty-five years has the Senate come up in force, and that only once did it outvote the resident majority. His picture of wicked conservatives "constantly" calling up non-residents to oppose progressive Radicals is just as devoid of fact as the assumption that Radicals are always progressive.

When, in 1910, a like charge was made against the Senate, I recited in the Senate-House a list of much-needed reforms and progressive measures (in all of which I was concerned), *e.g.* a proper audit and control of Departmental funds, the reform of the Press, the reform of the Fitzwilliam Museum, the founding of the Departments of Anthropology and of Architecture, etc., etc. (all of which had later to be carried out), and I charged to their faces the Radical leaders who then controlled the Council, with heading the obstruction to all these reforms. No one then or since has disputed my allegations. The suggestion that resident conservatives are an insignificant body is disproved by our important gains in the late elections to the Council (even without the much-needed secret ballot). My critic does not deny that the proposals of the Report respecting the powers of the Senate, the constitution of the Council and of the Board of Studies and Research go much further than the proposals made by the committee of younger graduates (men under 40) who represent the most advanced opinion among residents. They wish that the ultimate decision on statutes should rest with the Senate, and that the professoriate should keep its representation on the Council, and have some on the proposed new Board of Studies.

WILLIAM RIDGEWAY.

Flendyshe, Fen Ditton, Cambridge,
December 2.

LEAVING on one side the more personal aspects of Sir William Ridgeway's letter—his zeal for progressive reforms and the disingenuousness of his critic—a reply may be made to one or two of the points raised by him. He is mistaken in saying that the committee of younger graduates (men under 40) represent the most advanced opinion among residents. They have not unfairly been nicknamed "The Cambridge Whigs." Even this body, however, has suggested that members of the General Board (or Board of Studies and Research) should be nominated by the Council and that the Board should be reduced in size by abandoning the direct representation of the Special Boards of Study. It is held by many, who are equally keen with Sir William Ridgeway on the independent development of educational policy in the University, that the best solution lies in a small Board akin to the present Board of Research Studies, well balanced between the different faculties and working in close co-operation with the Special Boards. As to the question whether an appeal against the House of Residents would ever be made under the Commission's scheme, the writer differs absolutely from Sir William Ridgeway. Differences of opinion are too acute, and the fighting spirit of both sides too strong, to allow certain proposals to pass without a stern contest at every possible point.

THE WRITER OF THE ARTICLE.

Gravity Variations.

MR. R. D. OLDHAM'S letter in NATURE of November 18, p. 665, makes the disquieting suggestion that the force of gravity at Dehra Dun may be subject to fluctuations. The changes that he points out in the times of oscillation of the Indian pendulums can, however, be quite reasonably attributed to alterations in the lengths of the pendulums and errors of observation, and are not, in my opinion, so grave as to warrant a belief in anything more fundamental. As Mr. Oldham says, there is neither proof nor disproof of a change in gravity. But the discussion undoubtedly indicates a weak spot in the Indian operations, namely the connexion of Dehra Dun with Kew Observatory, which is the base station for this country. It rests on the results obtained with four pendulums swung at Kew and then transported to Dehra Dun and swung there. The pendulums have never been brought back to this country, so if they suffered any changes of length on the journey from Kew to Dehra Dun the value of g found at the latter place will be erroneous.

It would, of course, have been necessary to undertake a return journey long ago if no corroboration of the result of the first journey had been available. There was, however, the strong corroboration afforded by Hecker's observations in 1905, as mentioned by Mr. Oldham, and the valuable though less powerful evidence obtained by Alessio in 1906. Hecker's result was of special value because at Jalpaiguri his apparatus was set up alongside the Indian one and simultaneous observations were made using the same clock. Thus there was good reason to believe that the effects of fluctuations of temperature and variations in the clock's rate—the chief sources of uncertainty—would be the same on both sets of observations, and that therefore the check on the Dehra Dun value of g would be nearly as satisfactory as if Dr. Hecker's pendulums had been swung at Dehra Dun itself.

The links forming the connexion of Dehra Dun with the value of g determined at Potsdam are as follows:

	Result.
Potsdam—Kew (Putnam, 1900)	
Kew—Dehra Dun (Indian operations, 1904)	979·063
Potsdam—Jalpaiguri (Hecker, 1905)	
Jalpaiguri—Dehra Dun (Indian, 1905)	979·065
Potsdam—Genoa	
Genoa—Bombay (Alessio, 1906)	
Bombay—Dehra Dun (Indian, 1904)	979·059

The probable error of each of these results may be estimated to be between $\pm 0{\cdot}003$ and $\pm 0{\cdot}005$. The agreement between them is therefore better than the probable errors would have allowed us to anticipate.

Commander Alessio's observations in 1913–14, however, give a value of 979·079 for g at Dehra Dun, which differs from the above by nearly four times the probable error.

Alessio's observations were most carefully made with a strong equipment of eight pendulums, and carry great weight. They have not, so far as I am aware, been published in detail as yet, and it is not possible to form a final judgment on them; but in the article in the *Rivista Marittima* quoted by Mr. Oldham, there is a remark which may perhaps indicate a weak point. Commander Alessio says that the comparison of the times of oscillation of the pendulums at Genoa before and after the journey show that certain changes had taken place in the lengths of the individual pendulums, but that fortunately the length of the mean of the eight pendulums had remained absolutely unchanged. If the changes in the individual pendulums were large, and if they, or any of them, took place before the pendulums reached Dehra Dun, then the deduced value of g at Dehra Dun may be burdened with a considerable error.

Whatever opinion may be formed when the whole of the details of Commander Alessio's work are avail-

able for examination, it is clear that the Dehra Dun value of g should be strengthened by a new direct determination of the difference Kew—Dehra Dun.

This could be made by sending the Indian pendulums back to Kew for a further set of observations to be made there, or, if the use of Invar pendulums is contemplated, then the new set of pendulums could be employed for this purpose. It is imperative that the value of g at Dehra Dun should be established so thoroughly as to be unimpeachable.

G. P. LENOX-CONYNGHAM.

Trinity College, Cambridge,
November 29.

THE remarks by Mr. Oldham in NATURE of November 18, p. 665, relating to a suggested variation in gravity, are of great interest. As a result of measurements of g at Melbourne in 1913, a doubt as to the invariability of g relative to that at Potsdam was forcibly borne to mind. The report (Gravity Observations, British Antarctic Expedition, 1910–1913) which gives the results of the Melbourne measurements, has been delayed in the press, but it is felt that there is some evidence in this case of a lack of constancy in the value of g relative to Potsdam.

The problem is discussed in greater detail from another point of view in the Glaciological Report (Wright and Priestley), which is due to appear shortly.

C. S. WRIGHT.

Wey Lodge, Portmore Park, Weybridge,
November 20.

Action of Cutting Tools.

IN the interesting letters by Mr. Mallock and Prof. Coker which have recently appeared in NATURE, some points of importance to the elucidation of the action of a tool when operating on materials have been raised.

Mr. Mallock appears to adhere to the view expressed in his paper of 1881 that the action is simply a phenomenon of shear. H. Tresca, however, two years after Mr. Mallock's paper showed in his classical and extensive "Mémoire sur le rabotage des métaux" (*Mémoires présentés par divers savants à l'Académie des Sciences de l'Institut de France.* Tome 27, No. 1,

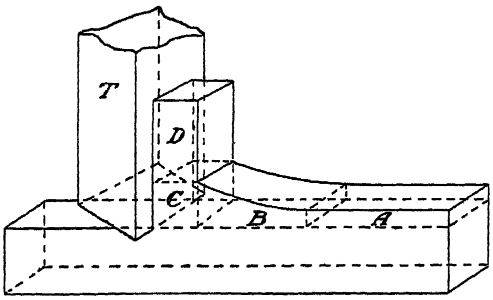

FIG. 1.

1883) that the phenomenon was primarily one of plastic flow. The periodic rupture of the chip which takes place is subsequent to the plastic flow stage and depends upon the nature of the material being operated upon, the angle the tool face presents to the advancing stream of material, and the velocity with which the material moves relative to the tool.

This stage of the action is complex and does not appear to be understood fully. The plastic flow stage, however, is comparatively simple.

In the diagram (Fig. 1) suppose that the tool T presents a plane face square to the advancing material. The portion A, which will ultimately form the chip D, as it approaches the tool begins to flow in region B, which is Tresca's *zone d'activité*. The flow reaches a maximum in the region C from which the chip or jet of metal D emerges, and Tresca in the light of the results of his remarkable and historical investigations on the flow and deformation of solids likens the action to the flow of the metal through a tube of shape ABC with its orifice open horizontally at the top part of C. Since no change in the density takes place the product of the co-ordinates xy (where the origin is at the tool edge) of a point on any surface in B and C continuous with a horizontal plane in A must be constant, so that the traces of these surfaces in the sides and also the free edges of B are hyperbolas.

This zone B can be seen in some of the beautiful photographs of cutting tools published by Mr. J. F. Brooks (Proc. Inst. Mech. Engrs., 1905, p. 365) and more especially in the last photograph of Plate 10. If now vertical lines be scribed upon the sides, the state of affairs during flow of a material which does not rupture for large body-shifts, such as lead, is represented by Tresca in Fig. 2.

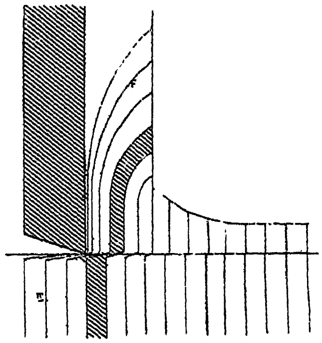

FIG. 2.

Here the maximum slide velocity is at the edge of the tool and in the horizontal plane through the edge. But one of the two important principles enunciated by Tresca is that during flow the maximum shear and maximum slide velocity are co-directional. We should therefore expect the material to rupture along this horizontal plane, and I think this can clearly be seen in Plate 11 of Brooks's photographs of the tool in action on mild steel.

Turning now to Prof. J. T. Nicolson's and Dempster Smith's experiments (*Engineer*, 1905, p. 358) and their diagram of the formation of a chip (Fig. 9), it may be seen that though the diagram is complicated by rupture phenomena and by the fact that the tool is acting on a wedge-shaped part of the forging, Tresca's representation of the plastic phenomena is well substantiated and the maximum shear is clearly seen in the initial stages.

The start of rupture along the horizontal plane is also clearly shown by Frederick Taylor in his presidential address before the American Society of Mechanical Engineers in 1906 (vol. 28), which is a monumental work on "The Art of Cutting Metals."

The same views are expressed by C. Codron in his extensive series of "Expériences sur le travail des machines-outils pour les métaux," published in the "*Bulletin de la Société d'Encouragement pour l'Industrie Nationale*," 1903–1905.

The second important principle enunciated by Tresca, namely, the maximum shear across any face of a small right six face is a constant = K (Tresca's plastic modulus), together with the one already mentioned, enabled Saint Venant to develop the general equations of plastico-dynamics. If the mathematicians

could concentrate on this subject, they would do industry a real service, for nearly all industrial operations such as punching, shearing, forging, milling, spinning, and, of course, the turning of metals, are plastic flow phenomena.

During experiments I carried out with heavy lathes in 1908 for the purpose of finding the most economical high-speed steel to use, I encountered some chips which were not only straight but actually presented concavity to the tool face, and I have one of these chips now. They were produced at very high speed on steel, and are mentioned in the discussion of a paper read before the Siemens' Stafford Engineering Society in 1908 (Proc., vol. 1, p. 93), on "The Plastic Deformation of Solids."

Brewster's beautiful photo-elastic method and Professor Coker's important applications of it enable the stresses during *elastic* strain of the tool and material in the region A to be computed, but Taylor, in the work cited, has shown how a tool should be forged and supported on the saddle to give it maximum life and maximum strength.

Unfortunately for engineering industry in this country, nearly all lathes are built with the vertical space between the upper surface of the tool rest and the line of centres far too small to enable Taylor's important conclusions to be put into practice.

ALAN POLLARD.

Imperial College of Science and Technology,
November 29.

I GATHER from Mr. H. S. Rowell's letter published in NATURE for December 9 that, while interested in the subject of the flow of metals in shavings, he is not altogether familiar with the work that has already been done on the subject. In a comprehensive "Mémoire sur le rabotage des métaux" (which cannot be so well known as I have hitherto believed) published more than forty years ago, M. H. Tresca investigated the question of the curling of shavings, both experimentally and mathematically, the actual flow of the metal (expressed by a *coefficient de réduction*) being especially selected for study under very varied conditions. The following quotation indicates only part of the scope of the work: "Ces phénomènes sont aussi ceux dans lesquels, pour la première fois, les métaux les plus durs, tels que l'acier, le fer, se comportent en réalité comme le plomb, comme le savon, comme le cire, nous dirions presque comme les liquides, tant est complet le rapprochement que l'on doit faire entre les rides de nos différents copeaux et de véritables vagues de métal."

The memoir is published as one of the "Mémoires présentés par divers savants à l'Académie des Sciences de l'Institut de France," tome xxvii., 1883. Those familiar already with the beauty of the results obtained will pardon this effort to direct the attention of others to the work.

E. N. DA C. ANDRADE.

Artillery College, Woolwich,
December 11.

The Secondary Spectrum of Hydrogen.

SINCE the negatively charged hydrogen atom is known to exist, from work on positive rays, it seemed likely that Silberstein's particular solution of the three-body problem, applied by him to the case of neutral helium (*Astrophys. Jour.*, September 1922) should also be applicable in this case. Consequently the formula used by him was modified so as to apply to hydrogen (charge E instead of 2E, and hence N instead of 4N), and also a small but important correction was made to the value of N so as to take account of the fact that with two electrons instead of one, the correction to the mass of the electron for the finite mass of the nucleus is no longer the same.

It was assumed as a first approximation that the electrons would be arranged antipodally, and consequently the forces would be again central. So Curtis's value of N for hydrogen was corrected so as to apply to a nucleus of infinite mass:

$$N_\infty = N_H\left(1+\frac{m}{M}\right).$$

Frequencies were then calculated from the formula

$$\nu = N_\infty\left(\frac{1}{n_1^2}+\frac{1}{n_2^2}-\frac{1}{m_1^2}-\frac{1}{m_2^2}\right).$$

These frequencies were then sought for in the secondary spectrum of hydrogen; it is known that negatively charged atoms are to be found in hydrogen at fairly high pressures with intensity quite comparable with that of the positively charged atom ("Rays of Positive Electricity," p. 39). As a result it was found that 47 lines in the secondary spectrum agreed with the calculated values within an absolute error of one unit of frequency, taking integral values of n_2 and m_1 from 1 up to 10, and values of m_2 from 1 to 15, while n_1 was taken as 2 and 3.

This means that the frequencies can be looked on as a kind of "summation tone," being the sums of a Balmer or a Paschen frequency and a frequency in the infra-red.

It was also found that in several cases a physical similarity of behaviour was common to "series" of the lines grouped according to the *m*'s and *n*'s concerned, though this was not exclusively true. As a standard of reference for the observed frequencies the values obtained by Merton and Barratt (Phil. Trans. A, 1922, pp. 388-400) were employed.

As typical may be given the following:—

Formula.	Calculated.	Observed.	Error $d\nu$.	Character.
$\frac{3\cdot9}{2\cdot6}$	16934·9	16934·51	+0·39	2++CD
$\frac{3\cdot10}{2\cdot6}$	17192·3	17192·14	+0·16	6++CD++HP+He
$\frac{3\cdot12}{2\cdot6}$	17527·6	17527·47	+0·13	3++CD+HP ++He
$\frac{3\cdot13}{2\cdot6}$	17638·8	17639·89	−1·09	0++CD ++He
$\frac{6\cdot6}{3\cdot3}$	18289·8	18288·26	+0·54	0
$\frac{6\cdot8}{3\cdot3}$	19623·4	19622·74	+0·66	0+He
$\frac{6\cdot10}{3\cdot3}$	20240·7	20240·71	−0·01	3 +LP

In the foregoing table, the figures in the last column refer to intensity and the symbols to the physical properties of the lines as given by Merton and Barratt (*loc. cit.*).

It is hoped to complete these and similar calculations shortly and also to investigate the conditions under which these lines should be enhanced.

A. C. MENZIES.

Physics Laboratory, The University, Leeds,
December 8.

Science and the Empire.

THE admirable sentiments expressed in the leading article in NATURE of December 16 will undoubtedly be re-echoed by every scientific worker in the country. In stating, however, that the British Science Guild is the only organisation which exists to undertake the propaganda work "for the extension of an understanding of the influence of scientific research and its results," the very effective propaganda which is being carried out by scientific workers themselves under the

ægis of the National Union of Scientific Workers is overlooked.

Of this body you say "it is a Trade Union affiliated, we believe, to the Labour Party, and it exists to secure suitable conditions of work and payment for its members rather than for the extension of natural knowledge." In that statement truth and error are intermingled. The National Union of Scientific Workers is a registered Trade Union; it registered as such when industrial and Civil Service joint councils on the Whitley plan were being set up and when it was announced that none but members of Trade Unions would be given representation on those bodies. The Employers' Federations registered as Trade Unions also and for the same reasons. But the National Union of Scientific Workers is not affiliated to the Labour Party or to any political party; it has no political funds, and it imposes no restraints upon the political activities of its members, three of whom stood for Parliament at the recent election, one in the Conservative interest and the other two as Labour candidates.

Again, while it is true that the National Union of Scientific Workers exists to secure suitable conditions of work and payment for its members—and all other scientific workers incidentally—it considers that the best way to do this is by raising the professional standard of scientific workers by improved training and education, and making them aware of their importance as citizens on one hand, and on the other, by pointing out to employers and captains of industry that it is an economy to employ the best scientific workers, to encourage research, and to assist the universities. In order to persuade private employers, corporations and governing bodies to deal justly with scientific staffs, it is true that the Union would be prepared to follow the methods employed by such bodies as the British Medical Association; but it believes with the British Science Guild that the attitude of the general public towards science is due to ignorance or apathy. Accordingly, it puts propaganda efforts, designed to cure these diseases, in the forefront of its programme, hoping thereby to increase the demand from industry and the State for the best scientific knowledge. It is ready to co-operate with any other body for this purpose, and to assist any political party with its advice on matters appertaining to science and scientific workers. It believes, however, that scientific workers themselves must be their own propagandists, and that the first step towards really effective action is unity in the profession of science.

A. G. CHURCH,
General Secretary.

National Union of Scientific Workers,
25 Victoria Street,
Westminster, London, S.W.1,
December 18.

[THE National Union of Scientific Workers is an occupational organisation; therefore its propaganda efforts, useful as they are, are naturally regarded by the public as arising from self-interest. The British Science Guild, on the other hand, requires no technical or other qualification for membership; and, as was pointed out in our article, it bears the same relation to scientific workers that the Navy League does to the Royal Navy. It seems to us that a body of this type, in which citizens engaged in many and diverse departments of national life are concerned, can afford much more effective and disinterested support of science than is possible by any group consisting of members of the profession alone. That was the main point of the article to which Major Church refers, and we see no reason to depart from it.—EDITOR, NATURE.]

The Hermit-crab (*E. bernhardus*) and the Anemone (*C.* (*Sagartia*) *parasitica*).

IN NATURE of December 2, p. 735, I described observations and experiments on the common hermit-crab (*E. bernhardus*) with its messmates, the anemone (*C.* (*Sagartia*) *parasitica*) and the polychæte worm *Nereis fucata*. By the kindness of Mr. Hugh Main, it has been pointed out that the observations mentioned above with regard to the natural position of the anemone confirm those of J. Sinel (p. 39, "An Outline of the Natural History of our Shores," 1906). Sinel states that "the woodcuts that appear in many text-books—even our high-class ones—which represent this anemone and its congener, are in one respect incorrect. The anemone is always represented as upright—palm-tree like—on the top of its equipage, as if its chief object were display—or a ride. . . . I have invariably found the anemone affixed to the rear of the shell and in such a position that when the hermit is at a meal or even moving about, the margin of the tentacles just touch the ground, like some patent sweeping-machine. It, no doubt, finds this position a paying one."

Sinel's unique and fascinating book contains a fund of information hidden away in a popular description of natural history on the shore. It is plain that, owing probably to the popular character of the book, many naturalists have passed over important original observations described therein by Sinel, whose knowledge of the biology of the shore has probably never been equalled.

Sinel's observations were previously unknown to me, but the agreement in the two sets of independent observations is valuable in opposing a traditional error, and will be sufficient to establish the correctness of the interpretations; the natural position of the anemone on the hermit-crab was clearly first shown by Sinel.

J. H. ORTON.

Marine Biological Laboratory,
Plymouth, December 13.

Winter Thunderstorms.

MAY I through your columns again ask for reports of thunderstorms occurring in the British Islands between January 1 and March 31? With the help of your readers and of observers of the British Rainfall Organization I was able to collect a mass of information on winter thunderstorms for 1916, 1917, 1918, and 1920, from which it appears that on more than 40 per cent. of the days in question, thunderstorms occurred somewhere in the British Islands. In collaboration with the Meteorological Office I propose to collect information again. The chief points to be noticed are the times at which the storms occur, and especially the times of passage of such storms as pass overhead; whether a severe storm or whether there are only one or two flashes of lightning or only one or two claps of thunder; whether there is a change of wind or a drop of temperature with the storm; whether there is rain, hail, or snow; in the case of lightning seen at night the direction in which it occurs; and any other information the observer thinks of interest. Reports are wanted especially from the west and north of Scotland, and from the south-west, west, and north-west of Ireland, but any information however slight from any district in the British Islands will be of great use to the investigation. Reports should be sent by postcard or letter to my address (not to the Meteorological Office).

C. J. P. CAVE.

Stoner Hill, Petersfield, December 20.

The Corrosion of Ferrous Metals.

IN 1916 a committee was formed by the Institution of Civil Engineers under the chairmanship of the late Sir William Matthews, with sixteen members of the Institution to investigate the "Deterioration of Structures exposed to Sea Action." The project was, in the first instance, submitted to the Department of Scientific and Industrial Research, which gave it every encouragement and promised the committee substantial financial assistance which has already amounted to several thousand pounds.

An important part of the committee's investigations is that connected with the corrosion of iron and steel structures exposed to sea action. In an exceptionally well-illustrated paper, read before the Institution of Civil Engineers on April 4, 1922, Sir Robert Hadfield gives a detailed account of the progress of the work down to that date.

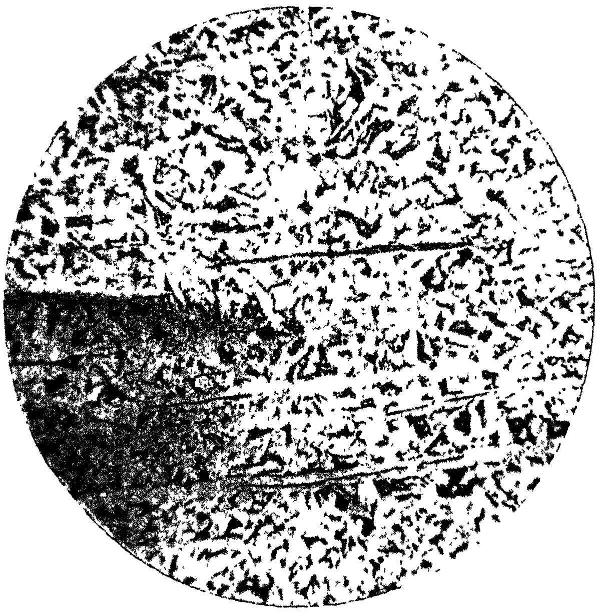

FIG. 1.—Mild steel (with 0·7 per cent. manganese). Longitudinal section × 100 (untreated).

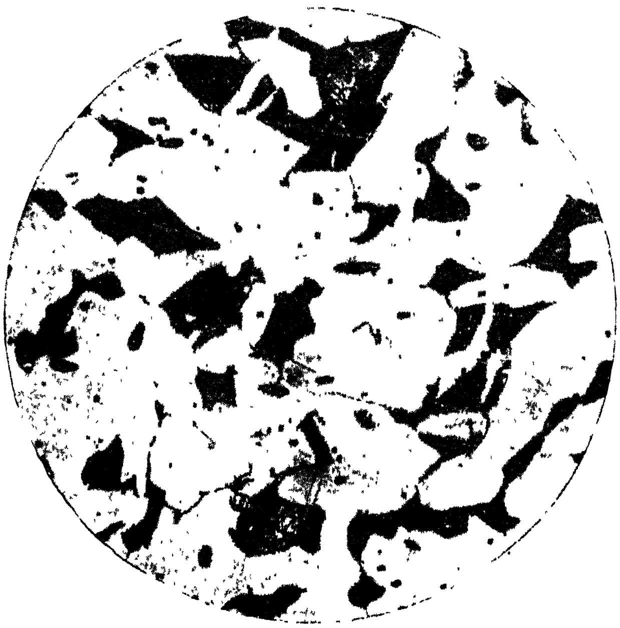

FIG. 2.—Mild steel (with 0·7 per cent. manganese). Transverse section × 600 (untreated).

The committee decided to expose fourteen types of ferrous material to sea action in various parts of the world and to determine by quantitative measurement their relative powers of resistance towards corrosion. The metals comprised "Armco" iron, Swedish charcoal and wrought irons, four types of carbon steel, cupriferous, nickel and stainless steels, and two samples of cast iron, cold and hot blast respectively. With the exception of the cast irons, the various metals were prepared in the form of rolled plates measuring 24 inches in length, 3 inches in breadth and 0·5 inch in thickness. The cast irons were of like dimensions, and were prepared by casting in the ordinary way. No further heat treatment was accorded the metals, for the committee considered that the tests would be of a more practical character if carried out with the metals in a condition resembling as closely as possible that obtaining in constructive work. In general the specimens were allowed to retain their outer skin of oxide, normally present on the rolled or cast metals; in two cases, however, additional specimens were prepared from which the skin was removed by grinding, in order to obtain information as to the effect of oxide layers upon the corrodibility of the metal.

Specimens of all the metals were subjected to various mechanical tests, such as the Izod and Frémont shock tests, and the Brinell hardness test. Tensile tests were carried out on bars cut in the longitudinal direction. Save in the case of the cast irons the bars were marked at regular intervals along their lengths, and, after pulling, their elongations from point to point were carefully determined. This was done in order to ascertain the effect of strain upon the corrodibility of the metal, the intention being to cut small test pieces from different parts of the strained bars and subject them to laboratory corrosion.

A duplicate set of tensile test bars, machined ready for testing, was prepared for immersion in that condition in the sea at Plymouth. After a prolonged exposure they will be removed and examined with the view of determining whether or not the mechanical qualities of the material are impaired. Very little work has been carried out on this aspect of the subject and the results obtained should prove of particular interest and value.

In addition to the foregoing, one bar of each material, excepting the cast-iron specimens, was suitably heat-treated in order to obtain test-data representing the physical properties of the materials under optimum conditions. The results obtained are detailed in the Appendix to Sir Robert Hadfield's paper and illustrate in a striking manner the enormous superiority in every

way of the heat-treated over the untreated metal. One illustration will suffice. In the case of mild steel, containing 0·25 per cent. carbon and 0·7 per cent. manganese, the yield point was raised by the heat treatment from 22·2 to 30·5 tons per square inch; the maximum stress from 33·5 to 42·8 tons; while the Brinell Ball Hardness Numbers rose from 145 to 197.

Needless to say, all the metals have been subjected to careful chemical analysis, and both the treated and untreated specimens have been studied photomicrographically, horizontal and longitudinal sections having been prepared of all the metals save the cast irons. This was rendered desirable in view of the fact that all the wrought irons and steels had been rolled. The longitudinal sections were taken at 100 diameters magnification, this being regarded as particularly suitable for examining the elongation of crystal grains due to rolling; the transverse sections were photographed at 600 diameters. Fifty-four beautiful reproductions of the photomicrographs are given in the paper, and four of these are reproduced in these columns through the courtesy of the Institution of Civil Engineers.

FIG. 3.—Mild steel (with 0·7 per cent. manganese). Longitudinal section × 100 (treated 900° water: 700° water).

FIG. 4.—Mild Steel (with 0·7 per cent. manganese). Transverse section × 600 (treated 900°, water: 700° water).

It is to be anticipated that the microstructure of the metals will play an important part in their powers of resistance to corrosion. Correlation of the micrographs and mechanical tests reveals several interesting features. In so far as the wrought irons are concerned, the heat treatment, by reducing the grain size, distinctly improves the shock test figures. The effect of heat treatment on the carbon steels has been, in the main, in the direction of preventing the marked separation of ferrite and pearlite, such as exists in the bars as rolled, and thus to produce a more homogeneous structure. This is well illustrated in the accompanying photographs.

This serves, in a large measure, to account for the better shock test results obtained with the treated material. It is calculated that in one of the mild steel specimens the number of grains per square inch is 820,000, while, when heat-treated, including quenching, the ferrite grains number about 5 million per square inch. This gives an idea of the closeness of the structure and the greater homogeneity produced by suitable heat treatment.

The necessary bars having been prepared, the committee were now faced with numerous problems connected with their despatch to various parts of the world, namely to Plymouth, Auckland, Colombo, and Halifax (Canada). One of the most difficult of these was the method of marking the bars. In view of the possibility in some instances of very severe corrosion, there was a distinct probability that any ordinary marking would be obliterated. It was intended that, when exposed to corroding influences, the two ends of the bars should be firmly embedded in concrete in a special frame erected for the purpose. Although a precise record would be kept of the position of each specimen in the frame, which would serve as some protection against mixing, there was the further danger that badly corroded bars might fall out of place and their identity be lost. The difficulty was eventually overcome by an ingenious system suggested by Mr. Maurice F. Wilson, a member of the committee, and now the chairman. The method consists in having one, two, or three holes drilled through the plates at both ends where they will be preserved by the enveloping layers of concrete. The holes are drilled in different positions; those at one end give what is termed the "classification letter" and indicate the type of metal, whether, for example, it is Swedish iron or cupriferous steel. At the opposite end the holes indicate the number of the bar.

In order to determine the effect of strain and of contact of dissimilar metals a few bars were bent at

right angles, others were fitted with ordinary rivets and bolts, while others were bolted one to the other. When all the bars had been carefully weighed they were packed in tin-lined cases and despatched to their respective destinations. The committee arranged that, at each place, one set of bars should be completely immersed in sea water; one immersed at half tide level, thereby becoming alternately wet and dry; and one set should be exposed to the sea air only.

When this comprehensive piece of research work is completed, the results should be of the greatest value not only to engineers but to all concerned in the use of ferrous metals.

Sir Robert Hadfield also gives an interesting account of the employment by the Admiralty of stainless steel during the war. Considerable difficulty had been experienced in consequence of the rapid corrosion of the diaphragms used in connexion with submarine hydrophones, which were put out of service in a comparatively short time. Messrs. Hadfield submitted experimental diaphragms of steel containing about 36 per cent. of nickel, and others of steel with a 12 to 14 per cent. chromium content. The latter alloy, the so-called "stainless steel," quickly proved its superiority, and was finally employed for the hydrophones. Although the nickel steel was very resistant to corrosion, its acoustic properties were not so good. These depend not only on the hardness of the metal but also upon its elastic limit, in both of which points the chromium steel was the superior. The diaphragms were placed in the hull of the submarine several feet below the water line, and it was noticed that although the surrounding plates of ordinary steel were soon covered with barnacles the chromium steel was entirely free. One of the diaphragms, after having been immersed in sea water under service conditions for six months was found to have undergone practically no alteration. A small film of a dark-brown deposit was noticed patchwise here and there on the surface, but this was easily rubbed away with the finger, revealing the bright metal beneath.

One diaphragm did manifest local corrosion, and a photomicrographic examination revealed a coarse grain due, in all probability, to over-heating. A portion was suitably heat-treated and restored to a normal condition, after which it showed the usual full resistance to corrosion.

As this chromium steel is one of the metals employed by the Corrosion Committee in their programme of tests, it will be particularly interesting, in view of the foregoing results, to see how this metal behaves.

In conclusion Sir Robert Hadfield very rightly directs attention to the economic importance of the problems of corrosion. Accurate statistics on the subject are, for obvious reasons, unobtainable, but Sir Robert estimates that the annual cost of wastage due to rusting is probably well over 700 million pounds sterling, this sum including an estimate for the cost of galvanising the metal, and allowance being made for painting, sheathing, etc., all of which processes would usually be unnecessary if the metal were not so prone to oxidise.

One feature of this estimate deserves special attention. The amount of the annual production of iron and steel by no means represents an equal increase in the world's stock of these materials. The quantity swallowed up merely in replacing wastage is enormous. We unite with the author in the hope that his memoir "will arouse still more attention than the subject has received in the past, and will create greater interest in the production of alloy steels, which have the capacity of resisting corrosion, if not entirely, at any rate to a much greater extent." J. N. F.

The American Museum of Natural History.

THANKS to the ideals of its president, the enthusiasm of its staff, and the abundant illustrations, the reports of the American Museum of Natural History are always interesting reading, and that for 1921 forms no exception. Indeed the president, Prof. H. F. Osborn, lays particular stress on this report, and he has reissued certain pages of it in a neatly bound booklet under the title of "The American Museum Ideal." That ideal he expresses in the words of Francis Bacon: "a model of universal nature made private. . . . A goodly huge cabinet, wherein whatsoever the hand of man by exquisite art or engine hath made rare in stuff, form, or motion; whatsoever singularity, chance, and the shuffle of things hath produced; whatsoever nature hath wrought in things that want life and may be kept, shall be sorted and included."

In short, the American Museum is become a world museum, and to that end it is sending out its explorers all over the world to gather and compare both for the benefit of Americans and for the benefit of every country which they may visit. Acknowledgment is made of the cordial co-operation which the American Museum receives from the Governments and scientific institutions of all those countries, while at home, thanks to the large development of the educational side of its work, the museum continues to enjoy strong support from the city government. By the latter at the end of last year the sum of 1,500,000 dollars was unanimously voted for the erection of two new sections of the building as originally planned in 1875. There is also under consideration, as previously noticed in NATURE, a special school service building to be devoted exclusively to school education in all its grades.

Prof. Osborn's ideal, however, goes far beyond this. He says, "It is evident that astronomy will be the central feature of our plans, because all the processes of earth's history and all the processes of life centre around original astronomic causes." Plans for an astronomical hall have already been drawn up and published, and have been confirmed by the trustees. All that is wanted is the money. It is estimated that the buildings when finished will cost not less than 9,000,000 dollars, and Prof. Osborn calls for a new general endowment of 2,000,000 dollars. This latter, he says, will not only restore the museum to its full-time efficiency, but will enable it to prepare to keep its promise to the city government; and when its Asiatic and Oceanic sections are completed the museum will be able to fill them with the specimens now in store, including many

large groups already prepared and others awaiting preparation.

The large amount of space, and consequently money, that is required is partly due to the plan on which the American Museum of Natural History is arranged. Our own Natural History Museum has its exhibited collections arranged on a systematic or classificatory basis, but in the American Museum the basis is faunistic or geographical, and an even more serious attempt is made to display the animals in associated groups and under their natural conditions. One of the most striking exhibits illustrated in the present report is an African elephant group (Fig. 1) opened to the public during the past year. This includes a male, a female, a young one, and a baby elephant, each in a different and characteristic position, and all together forming an impressive assemblage. This is the result of eleven years work by Mr. Carl E. Akeley, who went to Africa in 1909 to collect the material, and has since been developing and putting into effect a new method of mounting. No sooner was this finished than Mr. Akeley again left for Africa, where he has secured five fine specimens of the gorilla from the Lake Kivu District of the Belgian Congo. Another interesting exhibit consists of models of the marsupial frog of North America, Ascaphus, a primitive member of the Discoglossidæ. This frog lives only at high altitudes among the Olympics and other western mountains. A number of specimens were sent alive to the museum by shipping them in a device allowing water to drip continually upon them. They were thus kept alive nearly five months, while studies were conducted upon them. The extinct vertebrates form an important section of the American Museum, and reference is made to many new reconstructions and exhibits. A complete series illustrating the evolution of the horse is being prepared. This section of the report is illustrated by a photograph of Erwin S. Christman at work upon the model of Brontotherium. We regret to read that Mr. Christman, who had been connected with the department from boyhood as draughtsman, artist, and sculptor, died on November 27, 1921. Another illustration represents a vigorous wall-painting, by Charles R. Knight, of the vertebrates found in the asphalt deposit at Rancho La Brea, and includes the sabre-tooth tiger, ground sloth, Columbian mammoth, and an extinct vulture.

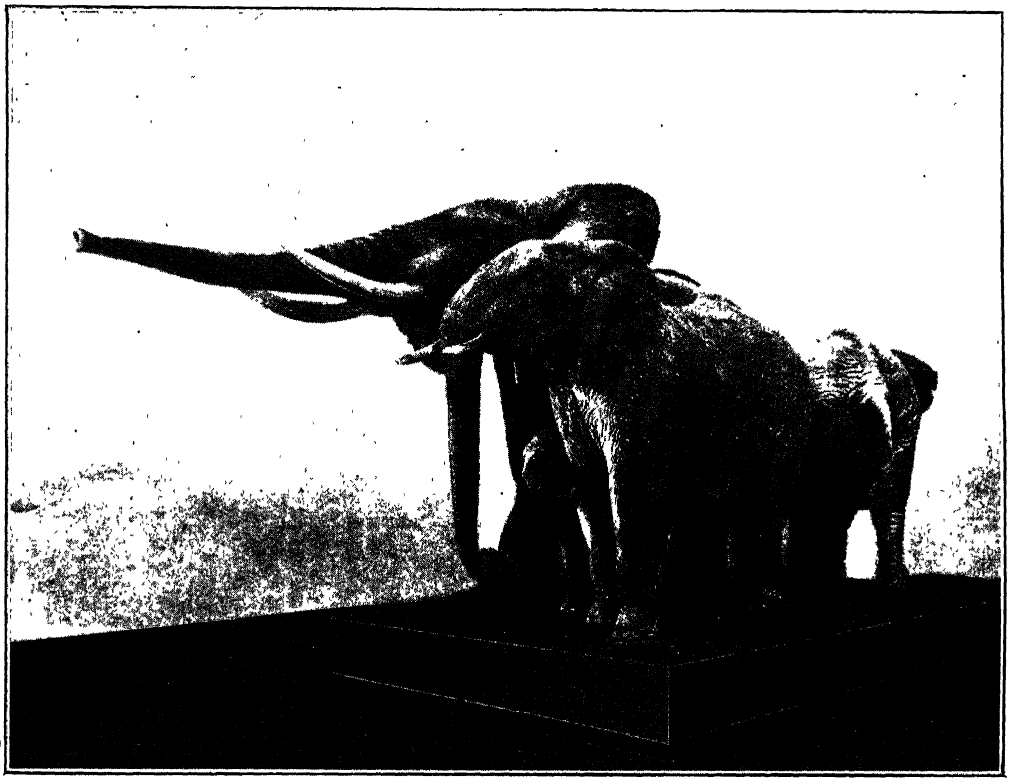

FIG. 1.—African elephant group in the American Museum of Natural History.
(From a photograph kindly supplied by the Director.)

Space does not allow us to comment on the very interesting reports from all the other sections of the museum, but we may remind our readers that the building serves as a centre for a large number of societies. So many as forty-three are mentioned as having held meetings, exhibits, or lectures at the museum during 1921. In addition to these the museum was the headquarters of the second International Congress on Eugenics, which Prof. Osborn considers to be the most important scientific meeting ever held in the museum. It was attended by leading eugenists from all parts of the world, and a special exhibit of genetics and racial heredity was prepared for it. Many members of the congress visited the museum to study this exhibit, and it is satisfactory to learn that

the newspaper press of the United States ended by according to the work of the meeting serious and satisfactory treatment. We commend this report to any one who wishes to learn in a pleasant and easy manner of the extensive and varied work that is carried out by a modern museum, and to those museum curators who may desire inspiration in their daily labours.

Presentation to Sir Edward Sharpey Schafer, F.R.S.

RATHER more than a year ago the suggestion was made that the Edinburgh meeting of the British Association would form a fitting occasion for the presentation to Sir Edward Sharpey Schafer of some token of their esteem from his present and past demonstrators and fellow research workers in London and Edinburgh. As so many of those who had been trained under Sir Edward now occupy posts in distant lands it was found impossible to make the necessary arrangements for the presentation at that early date.

Prof. Halliburton, however, made a statement at one of the largely-attended meetings of the Physiology Section of the Association, expressing the desire of all who had been associated with their old master in the prosecution of physiological research to present him with some mark of their esteem and affection, and indicated the form it would probably take.

Finally, it was arranged that the presentation should take the form of a full-sized plaque (Fig. 1), and that a medal replica should be presented to each of the many subscribers. The medal shows in bold relief the head and shoulders of Sir Edward, and bears on the reverse the inscription :—

Sodali bene merito
Sodales bene volentes
MCMXXII

[Photo by Drummond Young.]

FIG. 1.

The work was entrusted to Mr. C. d'O. Pilkington Jackson, A.R.B.A., sculptor, and has been carried out in an eminently satisfactory way. It is most artistic and, moreover, an excellent portrait. The large bronze plaque from which the medal was reduced has been mounted on stone, with the inscription underneath it (Fig. 1). Sir Edward feels that it should eventually come to the University of Edinburgh, but at present it remains in the sculptor's studio as he wishes to exhibit it at the Royal Scottish Academy.

The large list of subscribers includes many of the leaders in physiology and other branches of medical science in this and other lands, a few of whom may be named—Bayliss, Rose Bradford, Halliburton, L. Hill, MacWilliam, Mott, Starling, in this country; and Hunter and Tait (Canada), Jolly (S. Africa), Malcolm and Mackenzie (New Zealand), Addis and S. Simpson (U.S.A.), Row (India), Itagaki and others (Japan). Among the original subscribers were two of great distinction who have unfortunately passed away—A. D. Waller and Benjamin Moore.

The recognition of Sir Edward Sharpey Schafer's invaluable services to physiology by those who have worked with him in the laboratory is a matter for sincere congratulation in which all who have the interests of the development of medical science at heart will join. All will unite in expressing the hope that he has still before him many years in which he will continue his life-work.

Obituary.

F. B. BRYANT.

WE regret to record the death, on November 28, at the age of sixty-three, of Mr. Frederick Beadon Bryant, formerly Inspector-General of Forests to the Government of India. Mr. Bryant received his professional training at Nancy, joined the Indian Forest Service in 1881, and was posted to the North-West Provinces and Oudh. Some of the earlier years of his service were spent in the preparation of working plans for the important sub-Himalayan forests lying between the Ganges and the Sarda rivers. This early training, together with some years of successful executive work in his province, marked him out subsequently for the

post of Assistant Inspector-General of Forests and Superintendent of Forest Working Plans, which he held for three years from 1896. After holding successively the posts of Conservator of Forests in the Punjab and Burma and Chief Conservator of Forests in Burma, he became Inspector-General of Forests to the Government of India, an appointment which he held from 1908 till 1913, when he retired from the service of Government. Mr. Bryant succeeded to this post at an important period in the history of his department. The Forest Research Institute at Dehra Dun had been established two years previously on the initiative of his predecessor, Mr. (now Sir Sainthill) Eardley-Wilmot. It fell to Mr. Bryant to guide the destinies of the Institute in its earlier years, and his handling of this task was marked by sound common sense and careful judgment. A man of cheerful personality, he made a popular chief, and enjoyed to an unusual extent the goodwill of his department. In recognition of his services to Government he was awarded the C.S.I. in 1911. He is survived by a widow and grown-up family, to whom we extend our sympathy. He had the misfortune to lose one of his sons on active service during the war.

M. E. BOUTY, professor of experimental physics at the Sorbonne and member of the Academy of Sciences, died in Paris on November 5 in his seventy-seventh year. To the present generation of physicists in this country he was probably best known as the editor of the *Journal de Physique* and of the *Annales de Physique*, but to those of thirty or forty years ago he was the joint author of a text-book on physics much appreciated by all who wished to keep themselves up-to-date—the "Cours de physique de l'École Polytechnique" and its supplements. His principal published researches deal with problems connected with the passage of electricity through liquids and gases, but these memoirs by no means represent the whole of his work in the field of research. He succeeded in building up a school of research at the Sorbonne, and much work published by his pupils owed its inspiration to Prof. Bouty.

THE death, on December 10, is announced of Mr. Edward Degen, sometime of the staff of the British Museum and the Melbourne Museum. Mr. Degen was born in Basle in March 1852, and was educated in Basle and Paris. He travelled extensively and collected zoological material in West Africa, Uganda, Abyssinia, and Sakhalin. He was an expert taxidermist and had paid considerable attention to the moulting of birds, and to vertebrates generally. He was a Swiss and a citizen of Basle.

Current Topics and Events.

IT is stated by the Paris correspondent of the *Times* that the centenary of Pasteur was celebrated officially during the afternoon of December 26 at the Academy of Medicine. The French Minister for Health, M. Paul Strauss, was present, and a number of eminent medical men spoke on Pasteur's life and work. The Under-Secretary of Posts and Telegraphs has approved a design, showing a profile of Pasteur's head, for a special fifty-centimes postage stamp to be issued during the coming centenary celebrations.

IT may be remembered that, early in the present year, a proposal to prohibit the teaching of evolution in the schools of the State of Kentucky failed to pass the State legislature by one vote. In an article which appeared in NATURE of May 27 (vol. 109, p. 669), the opinion was expressed that further agitation with the same object might be looked for in the near future. That this apprehension was but too well founded appears by the fact that a "State-wide meeting of protestant ministers" in Minnesota has lately passed resolutions demanding that "the State shall prove its impartiality toward its citizens by dispensing with a subject (*i.e.* evolution) that is utterly divisive [*sic*]; and is, in the judgment of thousands of its taxpayers, utterly false." A reason given for this remarkable action is that "this hypothesis . . . has increasingly shown itself to be a foe to the Christian faith, denying as it does the veracity of the Scriptures." Such attempts at suppression are completely out-of-date, and the importation of religious intolerance into the question cannot but make the judicious grieve. The Minnesota meeting was perhaps not aware that the Catholic University of Louvain sent a special representative to the Darwin celebration at Cambridge.

YET another appeal has reached us on behalf of the famine-stricken people of Russia, this time from Dr. Nansen's committee by way of the Medical Aid Committee for Sufferers from the Russian Famine. It is addressed primarily to medical men, and, following out, apparently, the principle we have suggested in previous comments on these appeals, of approaching each group or profession on behalf of its co-workers in Russia, it is mainly for the assistance of medical men in Russia. It is stated that the latter, amid thousands of sick and starving people, are helpless for the lack of drugs and medical stores, and medical men here are asked to press for the formation of an international committee on medical relief to fight the effects of the famine. Men of science are needed to attack the sanitary and biological problems with which Russia and, through her, the whole of Europe are confronted. In the meanwhile supplies of medical and other stores will enable Russian doctors to struggle on with their task. Gifts in kind should be forwarded to the Secretary, Medical Aid Committee, 68 Lincoln's Inn Fields, W.C.2; contributions in money to the committee's treasurer at the London Joint City and Midland Bank, 6 Chancery Lane, W.C.2.

THE *Library Journal* for November 1 contains an article by Mr. E. C. Richardson, director of Princeton University Library, entitled "International Co-operation in Intellectual Work." Mr. Richardson refers to the recent appointment by the League of Nations of a Committee on Intellectual Co-operation, and writes with appreciation of the practical utility of three enterprises which this committee will necessarily take into consideration. Mr. Richardson

was present, as an observer, at the Brussels meeting of August 20–22 to consider the future of the great bibliographical undertaking carried on for so many years by M. Lafontaine and M. Paul Otlet. He gives an outline of what he saw at the Palais Mondial at Brussels, where a portion of the former exhibition building is devoted to international co-operation. The building contains not only libraries and card catalogues, but also a permanent exhibition of the activities of all nations and an International Summer University. MM. Lafontaine and Otlet have for years superintended this work, sustained by their zeal, without drawing salaries. Mr. Richardson also attended the Convention of the International Catalogue of Scientific Literature held at Brussels on July 22 and 24. Of this meeting he writes: "Not only were there nine or ten nations represented by official representatives, but several of these showed a very vigorous interest and a disposition to continue contributions and to assist in paying the accumulated debt." Mr. Richardson also visited the Concilium Bibliographicum at Zurich. With the aid of funds secured for the purpose by the American Research Bureau, the work of the Concilium, which had been in abeyance since the death of Dr. Field, has been taken up again vigorously by Dr. Kellogg and the new director, Dr. Strohl. It is expected that printing will be resumed next July. Mr. Richardson believes that, with these enterprises in bibliography in existence, a "Committee on Intellectual Co-operation" should be able to secure that, by a proper division of labour, the bibliography of science should be well and completely executed.

DR. SALAMAN's address to the Potato Conference at Ormskirk on November 2, which is published in the *Gardeners' Chronicle* for November 25, should prove of permanent value to horticulture, as while pointing out a present abuse it indicates at the same time that the remedy is ready to hand. Dr. Salaman dealt in vigorous language with the habit of seedsmen of listing the same variety of potato under different synonyms, frequently giving different descriptions to the variety upon its successive appearances, and often quoting it at different prices! The horticultural world is obviously concerned with the effect of the practice in commercial horticulture, but the scientific student of horticulture has to remember this ever-present source of error when he has to rely upon commercial firms for the supply of material in the form of cultivated plants for study or experiment. Fortunately the careful work now in progress at various plant-breeding stations throughout Great Britain, a work which is entirely disinterested from the commercial side of horticulture, is making it continually more possible to check the accuracy of popularly named varieties, not only of potatoes, but also of fruit stocks and scions, cereals, etc. Such work must precede any careful study of such a problem as the behaviour of a variety under continuous vegetative propagation, and bodies like the Synonym Committee of the National Institute of Agricultural Botany, of which Dr. Salaman is chairman, are rendering considerable service to science as well as to horticulture.

IN the Journal of the Washington Academy of Sciences (vol. 12, No. 15), Mr. T. A. Jaggar makes a plea for geophysical and geochemical observatories. Instruments of precise measurement need to be applied to the problems of geology. A record of the changes, for example, in a river system or mountain range, is essential if the processes involved are to be understood and given their due weight in the evolution of the earth's surface features. Geological science is lacking in measured facts of change within human time. The nature of changes may be gauged from temporary expeditions to different localities, but quantitative data can be obtained only by permanent observatories. The expedition method of study is never free from the reconnaissance element, and unexpected phenomena call for special instruments not included in the equipment. Moreover, there are seasonal and cyclic variations which an expedition misses. Mr. Jaggar cites his own experiences at the Hawaiian volcanic observatory as an illustration of how continuous measurement may reveal rhythmic recurrences. He dwells on the nature of the work which might be done by river and mountain observatories. A glacier observatory would be equally valuable.

IT is probable that the most important development of the cinematograph lies in its application to natural phenomena. To be able to make a leisured scrutiny of occurrences so momentary that the eye fails to hold them, is an inestimable gain. Appreciating the importance of such moving pictures, the Selborne Society has recently issued a list of cinematograph lectures ("Cinelogues") and films which, under arrangements made with leading film companies, can be hired on application to the society's Extension Secretary, Mr. P. J. Ashton, 72 High Street, Bromley. The topics dealt with are very varied, including the life-histories and habits of insects, birds, and other animals, both terrestrial and aquatic, the rites and customs of Australian aborigines, the physical properties of water and of air, the solar system, and others in the realm of science, besides a number illustrative of history, English literature, travel, and topography. The selection offered is admirable, and can be unreservedly commended to the notice of schools, societies, and other educational bodies.

WE have already referred in these columns (December 2, p. 743) to the film record of this year's Mount Everest Expedition, which was taken by the official photographer of the expedition, Capt. J. B. L. Noel. The film is now being exhibited at the Philharmonic Hall, Great Portland Street, W., so that all may have an opportunity of seeing this wonderful picture-story; the proceeds are to be devoted to the cost of a third expedition. It is a wonderful and inspiring entertainment. The first part shows the country through which the expedition passed on its way to Mount Everest, and it is ably described by Capt. Noel. The second section deals with monastic life in Tibet, and records the curious ritual dances which the party was so fortunate to see at the Rongbuk monastery at the very foot of Mount Everest. The

dances are performed by Lamas, attired in fantastic costumes and wearing huge masks, who represent the good and bad spirits the devout will meet in the next world; devil dances, dances in which ghouls carry a small dummy representing a dead body, and a procession of the gods, are among the scenes depicted. The whole scene is accompanied by music recorded by Mr. T. Howard Somervell, who has endeavoured to reproduce the actual sound of a Tibetan band. As may be expected, it consists largely of drum and trumpet, but there is a well-marked rhythm, and Mr. Somervell, who conducts the music himself, manages to keep his orchestra fairly well in time with the dançing figures on the screen, producing a most realistic effect. Anthropologists will welcome this record of Tibetan dances and music. The third section of the film shows the actual assault on Mount Everest. The film is described by Mr. Somervell, who formed one of the high climbing parties. Scene after scene of indescribable grandeur is shown. Many portions of the film, such as those showing the final attempts on the summit from the highest camp, at about 25,000 feet, were taken with a telephoto lens. The music played in the interval and during the exhibition of the film by Mr. Somervell is based on Nepalese and Tibetan airs and pastoral music, and some of the tunes provide very beautiful though simple subjects. "Climbing Mount Everest" is more than an entertainment; it is a story of high adventure, of great endeavour, which was robbed of success chiefly by the bad weather encountered in the last stage of the journey.

The College Board of the London Hospital is offering for competition the Liddle Triennial Prize of 120*l.* for the best essay on "Rheumatic Fever: its Cause and Prevention." The last day for the receipt of essays is June 30, 1923. They should be sent to the Dean of the College, Turner Street, E.1.

The Foulerton Award of the Geologists' Association for the year 1923 has been given by the Council to Mr. A. S. Kennard, F.G.S. Mr. Kennard was associated with Mr. M. A. C. Hinton in the paper on "The Relative Ages of the Stone Implements of the Lower Thames Valley," and with Mr. B. B. Woodward in the production of several important papers on the Post-Pliocene non-marine mollusca of England and Ireland.

The international review *Scientia* promises its readers next year "a great international inquiry into the Einstein theories." It proposes as the fundamental purpose, first, to make the theory itself accessible to all philosophically minded persons, whether or not they are mathematicians; second, to submit the theory to an objective, unprejudiced, exhaustive criticism, which, by making clear the weak points in need of revision, shall give them their true value as objections; and third, to endeavour to appreciate the value and importance of the theory and the part it has played in the general progress of science.

The following awards have been made by the Society of Engineers (Inc.) for papers read or published during 1922:—President's gold medal to Dr. C. V. Drysdale, for his papers "The Testing of Small Electrical Plant"; Bessemer premium to Mr. E. E. Turner for his paper "The Atlantic Cruise of H.M. Airship R 34"; Nursey premium to Dr. Herbert Chatley for his paper "The Physical Properties of Clay-Mud"; Society premiums to A. S. E. Ackermann for his paper "The Physical Properties of Clay" (fourth paper), and to C. H. J. Clayton for his paper "The Economics of Arterial Land Drainage"; W. Dinwoodie for his paper on "Wave Power Transmission"; Clarke premium to R. C. Hill for his paper on "The Submersible Pump"; and Geen premium to A. G. Short for his paper on "Heating."

A series of new charts of the currents of the North Sea is contained in a paper by Dr. G. Böhnecke (Veröfflich. Inst. f. Meereskunde, Berlin, N.F. Ser. A, Heft 10, 1922). The charts are based mainly on a study of the data representing the variations in the salinity of the area in question.

The Library Press, Ltd., 26 Portugal Street, W.C.2, will shortly publish a work entitled "Fur Dressing and Fur Dyeing," by W. Austin, consulting chemist to the fur industry, which is intended to cover very completely the subjects treated of, and to supply a want felt by workers in the industry.

Dr. C. Davison has in preparation (for publication in June next if enough copies are subscribed for) "A History of British Earthquakes," in which about 1200 earthquakes in the British Isles from 974 to 1921 will be dealt with. The work will be illustrated by 91 maps and 9 diagrams, and it will cost 32*s.* net. Orders should be sent, with remittance, as soon as possible to the author, 70 Cavendish Avenue, Cambridge.

A bibliography of meteorological literature, prepared by the Royal Meteorological Society with the collaboration of the Meteorological Office, is now given as a separate publication for each half-year. No. 2 of the series, which deals with literature received from July to December 1921, has just reached us. This half-yearly issue takes the place of the bibliography previously given in the Quarterly Journal of the Society. The publication has become of considerable value to a small body of workers actively engaged on meteorological research and to others who desire to keep abreast of advances in meteorology. Meteorological science is, without doubt, making considerable advance at the present time, and increased activity is given to the subject by such publications, especially with regard to the many intricacies of the upper air, not only in this country but by most countries the world over.

Dr. T. F. Wall thinks that the comment of our engineering contributor, appended to his letter in Nature of December 16, p. 810, may lead to a possible misapprehension as to wherein lies the novelty of the condenser formed by inserting in

dilute sulphuric acid two lead plates pasted with an oxide of lead—that is to say, using plates of the same nature as are used in secondary cells. The aluminium electrolytic condenser is an electrostatic type of condenser, whereas in the arrangement of pasted lead plates in dilute sulphuric acid the energy is stored in the form of chemical energy, and it is in this respect that the novelty of the new type of condenser appears. "For this reason," Dr. Wall adds, "the term 'electro-chemical condenser' more correctly describes the action of the pasted lead plate arrangement than the term 'electrolytic condenser.'"

THE third edition, recently issued, of the General Catalogue of the Oxford University Press is a volume of 480 pages. Supplementary to the catalogue itself is an alphabetical list of authors and editors extending to no less than 128 pages. A preface gives some interesting statistics, and the activity of the press is illustrated by the fact there stated, that it publishes, in one way and another, more than two books every day. The fifth section of the catalogue deals with books on natural science, including mathematics, physics and chemistry, astronomy, geology, biology, and the history and methods of the sciences. The present volume is more than a mere catalogue; besides giving many bibliographical details—including size in inches, number of pages, and date of publication—it sets out the full contents of books in several volumes and of joint works by several authors. It describes not only all Clarendon Press books, but also all books published by the press for learned societies other than the University of Oxford. The fact that many of these books are in their nature unremunerative affords good evidence of the service rendered by the press to the cause of education and learning.

Our Astronomical Column.

GREAT METEOR OF DECEMBER 6.—This brilliant object passed over Lincolnshire at $11^h\ 40^m$ and illuminated the north-east part of England with remarkable intensity. It was seen so far away as Armagh in Ireland, where the observer considered that its refulgence overpowered the light of the moon. A number of observations have been received, and they indicate that the radiant point was in Taurus at about $56° + 8°$, and that the luminous flight of the object commenced in the neighbourhood of Grantham; its direction was north-north-west. It passed nearly over Lincoln and Grimsby, and at the latter place its height appears to have been 24 miles. Continuing its course, it fell to about 2 miles in height when a short distance south-east of Hedon, near Hull, and about 2 miles further on probably fell to the ground. No meteorite has, however, been reported as having been discovered up to the time of writing, but such an object might very easily escape detection.

The meteor appeared so late at night that, in spite of its great lustre, it was noticed by comparatively few observers.

STELLAR TEMPERATURES AND PLANETARY RADIATION.—In an earlier communication, Dr. W. W. Coblentz gave estimates of the temperatures of sixteen stars as determined from their spectral energy distribution, which was obtained by means of a new spectral radiometer, consisting of a series of transmission screens and a vacuum couple. By means of these screens, which, either singly or in combination, had a uniformly high transmission over a fairly narrow region of the spectrum and terminated abruptly to complete opacity in the rest of the spectrum, it was possible to obtain the radiation intensity in the complete stellar spectrum as transmitted by our atmosphere. The standard used for comparison was a solar type star α Aurigæ, type G0. Being now equipped for making radiometric measurements of the sun, the effective temperature of which is known with a considerable degree of accuracy, Dr. Coblentz communicates the results of this comparison in the Proc. of the U.S. National Academy of Sciences, Vol. 8, No. 11, Nov. 1922. In this he describes the apparatus and method of procedure. He finds the agreement between the observed temperatures of α Aurigæ and the sun satisfactory, and thus verifies the previous measures of stellar temperatures, which range from 3000° K for red, class M stars, to 12000° K for blue, class B stars. In the case of the planets, Dr. Coblentz differentiates between the thermal radiation as a result of warming by exposure to solar radiation and the heat radiated by virtue of a possible high internal temperature of the planet itself. The planetary radiation he finds increases with decrease in the density of the surrounding atmosphere, and as a percentage of the total radiation emitted he gives the following values: Jupiter 0, Venus 5, Saturn 15, Mars 30, and the Moon 80.

SPECTROSCOPIC PARALLAXES OF B STARS.—Mr. D. L. Edwards read a paper at the meeting of the Royal Astronomical Society in November on the pioneer work on these stars that has been carried out at the Norman Lockyer Observatory, Sidmouth, where 200 negatives have been studied and the intensities of various lines correlated with respect to type and absolute magnitude.

The helium lines at 4472 and 4026 were found to be good indexes of spectral type, and by their aid some gaps in the Harvard series were filled. Line 4472 was found to vary also with absolute magnitude. The measures of the intensities of lines could be made very accurately by noting the point of disappearance in a darkened wedge.

The difficulty in getting absolute magnitudes was that very few trigonometrical parallaxes of B stars had been obtained. It was necessary to use also parallaxes derived from proper motions, and the hypothetical parallaxes already published for many binary stars. In the discussion it was noted that the assumed mass used in getting the latter was twice that of the sun, but that this is probably too small for B stars. The use of a larger mass would reduce the hypothetical parallax. For this and other reasons it was felt that, while there was every reason to believe the method would prove a very useful one, it was advisable to look on the calibration of the curves as provisional. Mr. Edwards used Kapteyn's value, $0''{\cdot}04$, for the parallax of η Tauri (in the Pleiades), but some recent determinations give $0''{\cdot}01$.

It is of particular importance to extend our knowledge of the limits of absolute magnitude of the B stars, since the results will have important bearing on the distances of the globular clusters.

Research Items.

SCIENCE AND PHILOSOPHY.—An article by Sir Oliver Lodge appears in the December number of *Scientia* on "The Philosophy of Science or the Principles of Scientific Procedure." Sir Oliver endeavours to draw a clear distinction between questions which definitely and legitimately belong to science, and those which, though of interest to science, belong to philosophy and cannot be answered by the ordinary methods and procedure of science. The size of an atom is an example of one, the infinity of space of the other. Sir Oliver is quite ready to admit that we can make no sharp separation between our philosophic, artistic, and scientific interests, which are an integral part of human nature and inextricably combined, but he seems to think that on the objective plane we can separate out the different realms and clearly demarcate their frontiers. No one is likely to dispute that there are certain kinds of fact which admit of being investigated with an isolation which is practically complete. What we want to know is whether any fact enjoys its isolation by right and not in consequence of a practical interest on the part of the investigator who contrives it? Some points in the article illustrate how doubtful this is. Sir Oliver attaches prime importance to the æther of space as a scientific explanation; would he class it as a scientific or as a philosophic problem? How can it be discussed without reference to the infinity of space, which is a question the man of science is to leave to the philosopher? Again, as an example of scientific deduction and prediction we are given the discovery of Neptune, but we are not told where to place or how to explain the failure to discover Vulcan.

OAT STRAW AS A CATTLE FOOD.—S. H. Collins and B. Thomas have an interesting paper in the *Journal of Agricultural Science*, vol. xii. pp. 280-286, 1922, upon "The Sugars and Albuminoids of Oat Straw." The authors set out to answer a question that first occupied the attention of one of them twenty-two years ago. "Why can cattle be fattened on roots and straw in Scotland and not in England?" Limitations of time apparently prevented the prosecution of experimental work then, and in the last twenty years there has been considerable development in our knowledge of animal nutrition, so that the authors can now attack with considerable precision the question as to whether the nutrients available in the straw will supplement the deficiencies of grain feeding. The answer appears to be that good oat straw, mainly owing to its relatively high percentage of albuminoids, may well do this, but oat straw has been found to vary in this percentage between 1·12 and 8·05. The low percentages are usually for the straw from the south of England, the high from Scotland; this may be, in part, a question of latitude, but the high figures for Cumberland and Westmoreland, and the values for differently manured crops, lead the authors to think that good husbandry and suitable supplies of organic nitrogen are even more important. These investigations certainly seem to bring the original question appreciably nearer solution. An interesting point in the sugar estimations reported is the fact that the main sugar of the straw appears to be lævulose, while the main digestible carbohydrate constituent of the grain is the dextrosan starch. If the ideal carbohydrate for nutrition be cane sugar, then this is an additional argument for the good straw proving a valuable supplement to the grain ration.

DEEP ROOT SYSTEMS OF CROP PLANTS.—The difficulties attending the study of the root systems *in situ* has led to a comparative neglect of this important branch of research until recent years. Prof. J. E. Weaver, F. C. Jean, and J. W. Crist, in the "Development and Activities of Roots of Crop Plants" (Carnegie Institution of Washington, 1922), are to be congratulated on realising the urgency of this problem. The value of this work is much enhanced by the numerous sketches of actual root systems made during excavation, together with full details of environmental conditions and experimental results. Repeated investigations at various stations indicate that all cereals possess two distinct groups of roots, one spreading in a more or less horizontal direction in the upper layers of soil, and the other penetrating deeply into the subsoil to a depth of six or seven feet. The lower roots are often much branched and appear to be of the normal absorbing type. In potatoes, on the other hand, the original shallow roots turn vertically downwards and form the deeper portion of the system. As a general rule, only the first six or eight inches of soil are regarded as being of much value in plant nutrition, but controlled experiments indicate that these deep roots play a great part in water absorption, as much or more water often being removed from a depth of three feet as from the surface layers. Maize was proved to absorb large quantities of water from the fifth foot. It was similarly shown that such fertilisers as nitrates were freely removed from the lower soil depths, to five feet in the case of maize, and at least two and a half feet with barley and potatoes. Furthermore, when roots came into contact with a fertilised layer they developed more strongly and branched more profusely, and at the same time normal penetration into the soil below was apparently retarded. The depth at which manures are placed in farm practice must therefore have a considerable effect on root development, and surface applications during times of drought may be very detrimental by keeping the roots from penetrating into the deeper layers with greater water supply. The authors conclude that "the deeper soils are not only suited to plant-life, but that they play an exceedingly important part in the life of the plant, and deserve careful consideration in a study of crop production."

BOTTOM-LIVING COMMUNITIES IN THE SEA.—A very full account of the biology of the Danish crustacea, *Gammarus locusta*, and *Mysis inermis*, *flexuosa* and *neglecta*, is given by H. Blegrad in the twenty-eighth Report of the Danish Biological Station (Copenhagen, 1922). The work has interest in connexion with Dr. Petersen's studies of bottom-living communities in the sea. It is not nearly enough that the numbers of animals inhabiting a unit area should be known; some good estimates of the rates of reproduction and the number of generations that occur throughout a year, for example, are necessary if we have to attempt a measure of the productivity of a sea-bottom area. The object of the memoir under notice is to supply some information on these subjects.

MOLLUSCS OF THE COLORADO DESERT.—Dr. S. S. Berry's notes (Proc. Acad. Nat. Sci. Philadelphia, lxxiv. 1922, pp. 69-100) on the molluscs of the Colorado Desert include short descriptions of specimens belonging to eight genera, most of them represented by a single species, but one genus (Micrarionta) is represented by five species, two of which are new. This land snail fauna is confined to the steep mountain slopes, while the fresh-water mollusca are centred

around the relict-covered bed of the ancient lake Cahuilla—*i.e.* the Colorado Desert in the exact original sense of this term. The enormous numbers of shells present in many parts of the valley and the discovery of many of the same species still flourishing in certain of the outlying springs and rivulets have long ago attracted attention to this section of the fauna. A list of papers on the mollusca of the Colorado Desert is given.

ANIMAL ASSOCIATIONS OF SOME CRUSTACEA.—A memoir on the Pontoniinæ—a sub-family of the decapod Crustacea—based chiefly on material in the collection of the Zoological Survey of India, is contributed by Dr. Stanley Kemp to the Records of the Indian Museum (xxiv. 1922, pp. 113-288, 9 pls.). A detailed systematic account of and keys to the genera and species are given, and Dr. Kemp directs attention to the ability shown by members of the sub-family to form associations with other animals. Some are found on sponges, others on actinians, on Alcyonaria, or on corals, a few on star-fishes and sea-urchins, many live on crinoids, a considerable number of species live in the mantle cavity of bivalve molluscs, and some are known from the branchial sac of ascidians. In the case of those which live in the mantle cavity of bivalve molluscs, in practically every example a male and female prawn are found together in the same mollusc, and Dr. Kemp infers that after the prawns are once established in their host they never leave it. A list of the animal associations recorded in the Pontoniinæ is given.

AMERICAN OLIGOCENE MAMMALS.—Mr. W. J. Sinclair has two papers on American fossil vertebrates in a recent number of the Proceedings of the American Philosophical Society (vol. lxi. 1922, with text figs.). The first, treating of "The Small Entelodonts of the White River Oligocene," discusses the relationships of *Archæotherium coarctatum*, Cope, and *A. mortoni*, Leidy, in the light of fresh specimens acquired by one of the Princeton Expeditions. After a careful analysis it is suggested that, so far as the assumed primitiveness of *A. coarctatum* is concerned, every one of its characters which might be regarded as primitive is possessed in some degree by specimens which differ from it in other respects, so that it would be necessary either to name every variant or to refer all to one species for which the name *A. mortoni* would have priority. The other paper, on "Hydracodons from the Big Badlands of South Dakota," distinguishes four specific types:—*H. arcidens*, Cope, *H. nebrascensis*, Leidy, *H. apertus*, sp.n., and *H. leidyanus*, Troxell; and their range in time is shown in tabular form. The distinctions between these species, or possibly subspecies, are based primarily upon structural differences in the upper posterior premolars. No intermediate stages have been observed.

THE LAVAS OF SNOWDONIA.—A marked gap in our detailed knowledge of the igneous rocks of the Snowdon area has been filled by Howell Williams in a recent paper in the Proceedings of the Liverpool Geological Society (vol. 13, part 3, p. 166, 1922). The author deals with the country near and mainly east of Capel Curig, tracing the devitrified rhyolitic lava-flows of Snowdon across the district. Considerable attention is given to alterations due to solfataric action, and the puzzling "bird's-eye slates," with their strings of small ellipsoids of calcite arranged across their bedding, are compared with those of the Lake District, and are attributed to an epoch when carbon dioxide was the principal escaping gas. These unusual rocks are limited to an horizon between the middle and uppermost rhyolites of the Capel Curig suite.

EARTH CURRENTS IN FRANCE.—In *La Nature* (November 25, p. 339, and December 2, p. 355) Dr. Albert Nodon has described a new series of researches upon the electric currents flowing in the earth. An observing station for this purpose was set up in the summer of 1921 near Sauveterre in the Basses Pyrénées; the district is far removed from any industrial electric circuits, being in a wide, well-watered prairie on clay soil, the humidity of which is probably fairly constant; it is therefore well suited in many important respects for such observations. Four overhead wires (the lengths of which are not stated) branch out in directions north-south, east-west, south-east to north-west, and south-west to north-east, from a small observatory. The earth-contacts at the ends of the wires were made by large zinc plates; the contact electro-motive forces from these plates annul one another and appear to have given no trouble. The currents were measured by a milliamperemeter, eye-readings being taken with a lamp and scale; no continuous photographic registration is arranged. The conductivity of the soil in various directions is measured from time to time by applying a known E.M.F. to the wires. Other observations include the earth's horizontal magnetic force, and the intensity of penetrating radiation, the latter being measured by a delicate electrometer in a closed metal case. The currents which flow along the direction of latitude appear to be small and invariable in direction, namely, from east to west; those from north to south are very variable both in direction and magnitude; the currents in the intermediate directions agree with the resultant of the east-west and north-south currents along these directions. The conductivity of the soil appears to vary in parallel with the intensity of penetrating radiation, and also to be augmented when the earth currents are large. Various other correlations, with meteorological and solar phenomena, are indicated, but the results can only be regarded as provisional in view of the short period over which the observations extend.

STREET LIGHTING.—A meeting of the Illuminating Engineering Society, on December 12, was devoted to a discussion on street-lighting. Mr. Haydn T. Harrison, in an introductory paper, pointed out the importance of correct distribution of light and described several devices for improving the natural distribution of illuminants, notably the holophane lantern and the "longitudinal system" for which he himself was responsible. He pointed out that the classification of streets in terms of minimum illumination adopted in the United States agreed closely with that recommended in this country, and urged that "minimum horizontal illumination" was the best basis of specification for public lighting. A contribution by Mr. L. Gaster dealt mainly with street lighting in relation to traffic, and some figures were quoted showing how the diminished lighting in war time had contributed to the increase in street accidents. Experiments in 32 American cities indicated that 17·6 per cent. of accidents occurring at night were due to inadequate illumination. Dr. Clayton Sharp gave an interesting survey of methods adopted in American cities. A feature of such tests has been the utilisation of a length of road for actual experiments with different forms of lamps. Another point, mentioned by Mr. Thomson, chairman of the Street Lighting Committee of the Westminster City Council, is the desirability of arranging lights so as to illuminate the exteriors of important buildings, so as to render them visible by night as well as by day. The advice of architects in considering this aspect of public lighting would be of value.

Weather Cycles in Relation to Agriculture and Industrial Fluctuations.[1]

TWO years ago Sir William Beveridge was led to investigate the problem of weather periodicity from a new point of view, or at least with materials hitherto unused—using wheat prices in past centuries as evidence of harvest yields and so of the weather. The investigation falls into three stages, namely:

(1) Construction of an index of wheat price fluctuation in Western Europe from 1550 to 1869, the index showing the price in each of those 370 years as a percentage of the average price for 31 years of which it is the centre.

(2) Harmonic analysis of this index for about 300 years to 1850 in order to discover periodicity. In this analysis all possible trial periods between $2\frac{1}{2}$ and 84 years in length have been examined and every apparent periodicity has been tested by analysing separately the two halves of the sequence. The result of the analysis is remarkable; not one or two but many distinct periodicities—thirteen or more—are suggested, and the suggestions are confirmed in varying degrees by the discovery of similar periodicities in meteorological records. In view of all the evidence, two of the periods—of 5·1 years (found independently by Capt. Brunt and Mr. J. Baxendell), and 35·5 years (found by Dr. Brückner in 1890)—may be regarded as "certain," though not necessarily the most important. Seven others, with lengths 5·67, 9·75, 12·84, 15·23, 19·90, 54·0, and 68·0 years, are classed as "nearly certain"; all of these show more strongly than the Brückner and many of them more strongly than the Brunt-Baxendell cycle. Four more periods of 3·41, 4·41, 5·96, and 8·05 years are "probable." There are six other "possibilities" including an 11-year period, corresponding in phase and in instability as well as length to the sun-spot period.

(3) Comparison of deductions from this analysis of wheat prices before 1850 with the actual rainfall from 1851 to 1921 on the assumption that the meteorological factor most uniformly adverse to wheat in Western Europe is rain.

For this purpose eleven out of the thirteen "certain," "nearly certain," and "probable" cycles, with the lengths and phases given by harmonic analysis, have been drawn for the years 1851 to 1921 and combined by a simple graphic method. The resulting "synthetic curve" shows a large measure of agreement with the actual rainfall for those years; for the 55 years to 1905 the coefficient of correlation is 0·38 or about five times its probable error. The principal droughts of the last seventy years, including that of 1921, are particularly well shown and so foretold by the "synthetic curve."

This investigation, it is submitted, establishes the existence, importance, and persistence over more than 300 years, of definite periodicities in the yield of European harvests, some or all of which must be attributed to cycles in the weather. It opens up the possibility of valuable forecasts of general conditions. But no such forecasts either as to the year 1923 or any other year are now possible, and Sir William Beveridge makes none. He claims for his investigation nothing more than that it affords a starting-point for more detailed studies; his hope is that competent meteorologists may be encouraged once again and more hopefully to take up these studies.

Mr. R. A. Fisher suggested that a periodicity in yields is not necessarily an indication of a periodicity in weather since it may indicate merely a periodicity of economic conditions. For example, the amount of a farmer's crop is affected by the state of the labour market and the state of his own bank account. Nevertheless, if any considerable and persistent periodicity really exists in the weather, it would be likely to affect the crops and hence their prices with a similar periodicity. The crop data suitable for an investigation of this kind should be obtained, however, not under commercial but under experimental conditions. The figures obtained at Rothamsted differ from those of the Ministry of Agriculture. Detailed examination of these figures and comparison with rainfall records, indicates that rainfall apparently accounts for 30-50 per cent. of the total variation in crop.

Examination of the distribution of the rainfall in each year shows that slow changes in yields seem to be affected only by (*a*) the total rainfall in the year, and (*b*) the excess of summer and winter rain over that in spring and autumn. Between the two latter there is a striking difference. In total rainfall there have been spells of wet and dry years, two wet spells about 35 years apart. But these spells can scarcely account for more than 10 per cent. of the changes in the yields, though they may account indirectly for a larger percentage, *e.g.* by favouring weed infestation. A period of 70 years is not enough, however, to determine periodicity; in any case the quantitative value of the spells is not great, probably less than 7 per cent. of the variation in crop: the remaining 93 per cent. appears to be quite fortuitous. It is here that the weak point occurs in any argument which would make the yield of farm crops to be dependent on the weather.

The change which variation in excess of winter and summer rain over that of spring and autumn causes is more interesting than that caused by total rainfall. Examination of ten-year means reveals a steady increase for the last 70 years with no sign of slackening. The effect of an increase in December rain on the wheat yield is rather striking; on dunged plots, for example, a loss of more than $1\frac{1}{2}$ bushels per acre occurred.

The general result of examining these weather records is that in most features the succession of seasons appears to be wholly fortuitous, and in all features by far the larger part appears to be fortuitous. The two cases in which distinct changes are noticeable account for a very small proportion of the variation in yield. It is of course not denied that any series of values, however arbitrary, may be expressed by Fourier's expansion as a number of harmonic cycles; but in the case of the weather, these cycles will be for the most part of short duration, and cannot be expected to reproduce themselves in the series of crop yields. For given weather the crop may be predicted with some accuracy, but Mr. Fisher is of opinion that the crop cannot be predicted even approximately without a detailed prediction of the weather.

Dr. Simpson remarked that meteorologists might be divided into two classes, those who had discovered a period and those who had not. The latter as a rule did not believe in periodicity, while the former generally believed only in the period they had themselves discovered. He exhibited on the screen a table showing 88 periods discovered by various investigators in solar and meteorological phenomena. These ranged from 1800 years to 2 hours, and he directed attention to the fact that from such a large

[1] Joint discussion of Section A (Mathematical and Physical Science), F (Economic Science and Statistics), and M (Agriculture) of the British Association at Hull on September 7.

number of periods—no attempt had been made to make the table complete—it would not be difficult to find a period near any specified period, especially if one were allowed to consider multiples and submultiples. He then discussed the two chief meteorological cycles, the Brückner cycle and the sunspot cycle. The hundred-year record of London rainfall has been analysed for a 35-year period, and a curve added to a diagram of monthly totals to show on the same scale the contribution of the cycle to the total rainfall. The amplitude of the cycle is absolutely insignificant in comparison with the monthly variations. Dr. Simpson admitted that there is an appreciable correlation between sunspots and meteorological factors, but as sunspots have no true periodicity they cannot introduce a periodic term into meteorological phenomena.

Turning to Sir William Beveridge's results Dr. Simpson regretted that he had not seen Sir William's recent paper in the Journal of the Statistical Society but only his papers in the *Economic Journal*, because the periods on which Sir William appears now to rely are different. He was prepared to admit that Sir William Beveridge had discovered certain periodicities in his curve of prices of wheat which were many times greater than one would expect by chance, but he strongly contested that these were meteorological periodicities. Sir William Beveridge laid great stress on a periodicity discovered by Capt. Brunt in Greenwich temperature, 5·1 years, which coincided with one of his cycles, but it was pointed out that Capt. Brunt discovered 9 cycles, four of which had greater and four smaller amplitudes than this particular cycle. Also Capt. Brunt's cycle of 5·1 years reduced the standard deviation of mean monthly temperatures at Greenwich only from 2·80 to 2·77, an insignificant change.

Dr. Simpson also criticised Sir William Beveridge's synthetic curve and asked why that curve should be compared with rainfall. There appeared to him no more reason why it should apply to rainfall than to any other meteorological or economic or even biological factor which might conceivably affect a harvest. In conclusion, admitting all that Sir William claimed to have done, he did not think that a prediction which gave a correlation coefficient with actuality of only 0·38 had any practical value. When Sir William had increased his correlation coefficient to about 0·83 he would be a valuable forecaster, but not until then.

Mr. Udny Yule said that the comments of Dr. Simpson seemed to him unfair. It must certainly be recognised that mere inspection of data was wholly inadequate and might lead to unfounded ideas as to the existence of periodicities, but this criticism had no bearing on work carried out by the periodogram method. He felt a good deal more doubt than some previous speakers on the question whether crop cycles were or were not a vital factor in the general economic cycle, which required far more study. From the statistical side the most important work now to be done is the determination of the crop cycles in areas other than Western Europe, *e.g.* South America and India: in so far as crop cycles are an important factor in the economic cycle, the resultant in any one country must be a complex effect dependent on the sources of its raw materials. On the side of economic theory it seemed to him there is also work to be done. The treatment of economics is in general static. The economist is too apt to tell us that " in the long run " a pendulum will hang vertically, whereas the whole interest of the pendulum is that it swings, and the problem is why it swings and how it swings. The treatment of economics should be dynamic. The question might be asked, for example, whether there is not an equation relating production not merely to price but to price and its time differentials, an equation which might (or in given circumstances might not) have a periodic solution.

Prof. H. H. Turner considered that we should be grateful to Sir William Beveridge, first, for producing a long series of annual values, going back much further than our longest rainfall record; secondly, for having himself analysed them completely by the periodogram method, so that others can profit by his analysis; and thirdly, for two considerable successes in the outcome. One of these is remarkable. He had succeeded in forecasting the weather in some sort—a rare, if not unique, achievement up to the present. The other success consisted in isolating several periods which must be further investigated. The periodogram gives us only the beginning, not the end of an investigation. Having obtained, for example, the definite suggestion of a 15-day period we must then see how it behaves throughout the series; the maximum phase seems to oscillate in this case. Such oscillations frequently occur in manifestations of periodicity which may itself be quite regular; thus, the rotation of the earth is quite regular, but one of its manifestations is sunrise, which swings to and fro. Sir William Beveridge had given us a good start, which it is to be hoped will be followed up.

Geology of the North Sea Basin.

THE long-standing custom of devoting at least part of a session of the Geological Section of the British Association to matters pertaining to the geology of the district in which the meeting is being held, was extended this year to the consideration of the wider question of the geological history of the North Sea basin, the discussion on this subject being the first of a series held in different sections on various aspects of the North Sea.

The discussion was opened by Prof. P. F. Kendall, president of the section, and was continued by Mr. J. O. Borley, of the Fisheries Research Laboratory, Lowestoft, who described the nature and distribution of the deposits now being laid down. Mr. Thomas Sheppard dealt with the geology of the Hull district, and Mr. C. Thompson contributed an interesting paper on the present rate of erosion of the coast of Holderness.

The main tectonic lines of the British Isles and of the neighbouring area, the North Sea, were produced prior to the formation of the Permian rocks, the three main axes of folding being the Caledonian (N.E. and S.W.), the Pennine (N. and S.), and the Armorican (W. and E. approximately). Later movements, for the most part along these old lines, were responsible for the changes in the distribution of land and water which have taken place.

The region now occupied by the North Sea appears to have been an area of depression since a very remote period. Thus it is found that movements which took place during late Carboniferous times and during the period, unrepresented by any deposits in Europe, that elapsed before the deposition of the Permian rocks, caused the coal measures to dip into the basin in Holland and Belgium, in Northumberland and Durham, and probably also in Lincolnshire, to re-emerge at Ibbenbüren.

The sinking of the basin thus formed appears to have continued intermittently in Permian, Jurassic, and Cretaceous times, the Permian and Jurassic deposits in the Durham-Yorkshire area being thicker than in almost any other part of Britain, and the Lower Cretaceous beds (the Speeton clay), being of a deep water type, contrasting strongly with the shallow water and estuarine deposits of that age to be found in parts of Britain more remote from the basin. The chalk also reaches its maximum British development on the East Coast.

After the formation of the chalk, the area was uplifted and much denudation took place prior to the deposition of the Woolwich and Reading beds and London Clay, which marks the commencement of a further downward movement. These Lower Tertiary beds still occupy the London and Hampshire basins and extend below the southern part of the North Sea. Prior to the great denudation which followed the uplift in Miocene and early Pliocene times, they doubtless occupied a much wider area—the then basin of the North Sea with its embayments and estuaries.

Then followed intermittent movements of the Armorican folds in the south of England, Northern France and Belgium extending into Pliocene (Diestian) times.

From this time onwards it is possible to trace the southern and western shores of the North Sea with some degree of accuracy. In Diestian times, Harmer suggests that the coast-line ran from the neighbourhood of Dover across the straits into Belgium, the shore deposits being represented by the Lenham beds and the Diestian of Belgium. The later Pliocene deposits indicate a gradual retreat of the sea to the northwards, the fossils of the Red Crag and Norwich Crag showing a gradual increase in the number of living as compared with extinct species as they are traced from Essex to the Wash.

At the close of Pliocene time much of the southern portion of the North Sea Basin must have been low-lying land, and across this meandered the great rivers of Northern Europe. The estuary of the Rhine, according to Harmer, crossed Norfolk; and in it were laid down the Chillesford beds.

To the north of the Humber the coast-line of this period has been traced by a line of buried cliff with accompanying beach deposits running from Hessle on the Humber, inland to the west of Beverley, and emerging on the line of the existing coast at Sewerby, between Bridlington and Flamborough Head. The plain of marine denudation in front of this old coast-line has been charted and contoured by means of information obtained from numerous borings which have been put down in search of water in the Plain of Holderness.

The next phase was a retreat of the sea and the formation of sand dunes along the foot of the cliff. The geological date is indicated by the occurrence of *Elephas antiquus*, *Rhinoceros leptorhinus*, and hippopotamus in the deposits, a fauna which accompanies implements of Chellean type in the south of England.

Throughout Pliocene times, a gradual refrigeration of the climate was in progress, as is shown by the molluscan fossils and also by the land flora, where remains of this have been preserved; and the next episode was the formation of a great ice-sheet having its radiant point in the neighbourhood of the Gulf of Bothnia. This appears to have displaced the waters of the North Sea at least as far south as the coast of Essex. Retreats and readvances took place, but the final retreat of the ice can be traced with great detail and precision by the drainage phenomena developed along its margin up to its last contact with British shores on the Ord of Caithness.

Oscillations of level accompanied the retreat of the ice and raised beaches were left, but on the completion of the withdrawal the land stood about 80 feet higher than at present. The southern part of the North Sea became a marshy plain, peat bogs covered much of its surface and forests clothed its margins, while great rivers such as the Rhine, Thames, and Weser meandered through it.

A depression to the present level then ensued and the great shallow bay of the North Sea south of the Dogger Bank was formed. The sea ran up the estuaries, and thus the Humber itself and its tributary the Hull came into being.

The work now being carried out by the officers of the Fisheries Board is throwing much light on the distribution of the various grades of material accumulating on the floor of the North Sea at the present time. Both the mineralogical character and the size of grain of the material are being investigated, though, of course, the latter is of more importance from the immediate point of view of fisheries, since it controls to a large extent the distribution of life.

By means of experiments with floats the direction of the main surface currents has been determined, and the maps exhibited by Mr. Borley showed that the floor deposits were spread out under the influence of the same movements. Several different types of material exist on the coast, but in each the grading of the deposits, coarse to fine, is in the general direction of the currents already determined by other means.

Along a great part of the east coast of Britain the North Sea is at present eroding the cliffs at a fairly rapid rate, and this has been measured by Mr. Thompson in the case of the coast of Holderness, which consists of glacial deposits. His method was to take the six-inch Ordnance Survey map published in 1852 and to measure thereon the lengths of all easily identifiable lines running at right angles to the coast, and then to measure up the remains of these lines on the ground. In this manner it was possible to draw the coast-line as it is to-day on the map of 1852 and thus to indicate the strip of land lost to the sea in the last seventy years. This strip varies considerably in width in different parts of the coast, there being a few points at which erosion is practically nil while at others it has caused serious loss.

New Japanese Botanical Serials.

DURING the last few decades the universities and colleges of Japan have produced a large number of scientific investigators, many of whom have continued postgraduate training for several years in Europe or America. The result is that in Eastern Asia a large number of well-equipped scientific investigators are now actively prosecuting research and there is a danger that, working in a field still far distant as regards practicable modes of communication, their work may not be sufficiently known in Europe, with corresponding loss of efficiency to the workers in both continents. Japanese scientific leaders are evidently alive to the danger, and the reopening of extensive scientific contact following the gradual cessation of war conditions has been followed by the organisation and issue of a number

of scientific publications, containing communications in European languages, mainly German and English.

Thus there have recently reached this country the first issues of two such new serial publications, the *Japanese Journal of Botany* and the *Acta Phytochimica*.

The *Japanese Journal of Botany* is only one such publication of nine which are being issued by the National Research Council, Department of Education, Japan. Besides a long communication (53 pp.) by Saito upon the fungi (yeast) occurring naturally in the atmosphere at Tokio, in which a connexion is traced between the number of these organisms present and the meteorological conditions, a series of abstracts follow which summarise the more important papers on botany and allied subjects which have appeared in Japan during January-June 1921. No fewer than thirty-nine papers are thus reviewed, many of economic importance and some of very general interest.

The first number of the *Acta Phytochimica*, dated March 1922, contains two papers. In the first Asahina and Fujita summarise the researches published by them so far only in the Japanese Journal of the Pharmaceutical Society of Japan. These investigations enable them to assign a constitutional formula to anemonin and to the most important acid derivatives so far obtained from it.

Anemonin is a crystalline product obtained from the acrid ranunculus oil distilled from fresh plants of various species of the Ranunculaceæ and extraction of the distillate with ether, benzol, or chloroform, but anemonin itself is not the acrid principle. The Japanese workers have a very large phytochemical field in the many interesting natural products of Eastern Asia, and the second paper, by Majima and Kuroda, deals with the pigment extracted by cold benzene from the dried outer portion of the root of *Lithospermum Erythrorhizon*. The main constituent of this pigment has been isolated in pure crystalline form and is described as the monoacetyl derivative of the compound, $C_{16}H_{16}O_5$, which the authors have named shikonin (from the Japanese name for the plant "shikon.")

It is proposed to issue one volume of *Acta Phytochimica* a year, each volume to consist of about 350 pages. The editor is Prof. K. Shibata, Botanical Garden, Koishikawa, Tokyo.

The two papers now published are written, one in German and one in English; communications in French are also acceptable for publication. The journal states that it aims at ensuring a closer correlation between chemical and physiological studies of plant constituents, but these first papers are essentially chemical in outlook. Both journals are well printed, in clear type on good paper, with curves and tables adequately reproduced. In the *Japanese Journal of Botany* three plates are included. Curves and drawings are very well reproduced in these; a lack of contrast in a series of photographs of yeast colonies on agar may be the fault of the original photographs.

Colloid Chemistry.

By Prof. W. C. McC. LEWIS.

THAT increasing attention is being paid to the subject of colloid chemistry is becoming manifest in various directions. Already the subject has taken its place in the chemical instruction of some if not of all our universities, while the technological literature shows (though as yet to a rather limited extent) that the significance of colloidal behaviour is no longer overlooked in a number of technical operations. The subject is one of comparatively recent growth, for, although originating with Graham more than sixty years ago, its importance has begun to be realised only within the last twenty-five years.

It is not altogether surprising, therefore, that there are still a number of people engaged in chemical work to whom colloid chemistry has not as yet made an effective appeal. To a large extent the further recognition of the subject will depend not only upon the measure of success attending the publication of works such as text-books and memoirs which aim at bringing the subject within the scope of ordered presentation, but also upon the efforts of agencies the aim of which is to correlate the scientific principles and generalisations (in so far as they exist at present) with technical problems and practice, and to demonstrate how numerous and varied are the industrial operations in which colloid considerations are fundamentally involved. In the latter connexion a very useful service has been performed during the past few years by a committee of the British Association in publishing a series of reports on Colloid Chemistry and its General and Industrial Applications. The fourth of these reports,[1] a compilation of more than 380 pages, has been issued, and in view of its undoubted importance a brief indication of its general nature will not be without interest.

As in previous reports the subject matter is considered so far as possible under two heads, namely, subjects mainly academic in nature, and subjects mainly technical. Under the first head we find the following sections: Colloids in analytical problems, cataphoresis, colloid systems in solid crystalline media, molecular attraction, membrane equilibria, disperse systems in gases, the theory of lubrication, and the application of colloid chemistry to mineralogy and petrology. Under the second head are grouped: Colloid chemistry of soap boiling, flotation processes, catalytic hydrogenation, the rôle of colloids in metal deposition, rubber, and colloidal fuels. Each section has been written by a man who is specially conversant with the subject which he treats, and it may be added that the entire work here represented—and it amounts in the aggregate to much—has been given gratuitously.

Among subjects of such a divergent kind it is not easy to discriminate. Some readers will be attracted by the comparative novelty of the idea of introducing colloidal considerations at all into such problems as metallic alloys, mineralogy, and petrology, or the subject of lubrication. Others will be specially interested in obtaining some definite and clear information on subjects which possess a certain degree of familiarity, but about which most of us have, it is to be feared, somewhat confused ideas, subjects such as soap boiling, or ore-flotation, or catalytic hydrogenation. The fact that the latter two subjects are dealt with at all indicates the wide view which the committee quite rightly takes of the nature and range of its activities. The enormously wide scope of certain of the subjects themselves is well demonstrated by the article on disperse systems in gases, which ranges from the pollution of the atmosphere, metallurgical smokes, and problems of chemical warfare to Millikan's work on the charge of the electron. By way of contrast we find in the section on molecular attraction a minute and searching

[1] Department of Scientific and Industrial Research: British Association for the Advancement of Science. Fourth Report on Colloid Chemistry and its General and Industrial Applications. Pp. 382. (London: H.M. Stationery Office, 1922.) 5s. 6d. net.

account of a single problem which is fundamental not only to colloid chemistry but to molecular physics as well. The variety of the subjects here indicated should strengthen the appeal which the report makes to readers possessing widely different individual interests.

Finally, it may not be out of place to direct attention to the valuable assistance which the committee has received from the Department of Scientific and Industrial Research, without which the report could not have been published. To any one appreciating the value of these publications for the advancement of chemical science and industry, it will be apparent that the assistance thus rendered has been wisely as well as generously given.

Early History of the Sussex Iron Industry.

MR. RHYS JENKINS, vice-president of the Newcomen Society, formed recently for the study of the history of engineering and technology, who has contributed two papers on the early history of the iron industry in Sussex, has followed this up by some notes on the early history of steel-making in England. His paper deals with the history of the production of steel before Huntsman's invention of cast steel.

That steel was produced in the time of Queen Elizabeth is well known, but very little, if any, research has been done on the history of the industry between that period and about 1750. The earliest mention of a works for the production of steel found by the author is in 1573. He finds that John Glande held a tenement called "A forge of steel" in Ashdown Forest, Sussex. This forge came into the hands of John Bowley in 1525, who still held it in 1548. It appears that Sir Henry Sidney of Penshurst, Kent, the father of Sir Philip Sidney, was a steel maker of that period. Steel was manufactured at Robertsbridge in Sussex with the aid of Dutch labour obtained from the neighbourhood of Cologne. The method used was the so-called "finery" process, in which the iron from the blast-furnaces, instead of being cast into sows or pigs, was cast into thin flat bars. Another site of steel forges in Sussex was Warbleton.

An important landmark in the development of the industry was the invention of the cementation process. The earliest mention of this is in 1614, when William Ellyott and Mathias Meysey obtained a patent for converting iron into steel "by means of a reverberatorie furnace with potts louted or closed to be put therein containing in them certain quantities of iron with other substances, mixtures and ingredients, which being in the said furnace brought to a proportion of heate doth make and convert the same iron into steel, which steel with other heate temperatures and hammerings to be afterwards given to the same doth make good and fitt for the use before mentioned." Ellyott and Meysey were both natives of this country, and there is no suggestion that they employed foreign workmen. The author thinks that this invention may have been a development of the case-hardening process, possibly in the light of knowledge acquired from the manufacture of brass. The works of Ellyott and Meysey were probably situated in London, and in 1616 they obtained another patent for carrying out the main invention with pit coal instead of wood.

Later developments of the industry appear to have taken place to some extent in the Forest of Dean, and also in Yorkshire. Prince Rupert was an inventor of the period, about 1650. On the whole, the best steel seems to have been made in the Forest of Dean. The records of that period indicate that it made good edge-tools, files, and punches.

University and Educational Intelligence.

CAMBRIDGE.—Dr. A. P. Maudslay has been elected an honorary fellow of Trinity Hall.

GLASGOW.—The University Court has accepted the generous offer, already referred to in this column, of a gift of 25,000*l*. from Mr. Henry Mechan for the establishment of a Henry Mechan chair of public health. In making the gift, in recognition of "the great and important work which is being done by the University of Glasgow," Mr. Mechan made no conditions, preferring that "the accomplishment of my purpose should be left to the University authorities." The department of public health to which the new chair is given has hitherto been joined with that of medical jurisprudence under Prof. Glaister.

LEEDS.—At the meeting of the Court of the University on December 20, the Pro-Chancellor stated that there are now 1535 full-time students as compared with 1646 in the year 1921–22. The local education authorities of Yorkshire are increasing their help to the University. In addition to subsidies from the City of Leeds, the West Riding and the East Riding County Councils and the City of Wakefield, the University now receives financial aid from the North Riding County Council and from the City of York.

The laboratory of the British Silk Research Association has been established in temporary quarters, and the National Bensole Association has instituted researches in the department of fuel and metallurgy. The premises used as a Marine Biological Laboratory at Robin Hood's Bay have been purchased by the University. With the help of a grant from the Government the funds required for the new building of the department of agriculture (the headquarters of agricultural education in Yorkshire) have been secured, and an early start will be made with the work.

The Clothworkers' Company has recently made to the University a gift of 2250*l*. in addition to its earlier munificent endowments.

The Court, on hearing of Prof. Smithells' decision to resign the professorship of chemistry in order to devote himself to scientific investigation in London, "records its profound gratitude to him for service of immeasurable value to the University during the thirty-seven years in which he has held his Professorship. He is one of the founders of the University, which owes more than it can ever express to his unselfish devotion to the public interest, to his untiring labours in the application of science to industry, to his strenuous and at last victorious defence of the recognition of scientific technology as an element in the highest type of university education, and to his undeviating adherence to a high and exacting standard in university studies. The Court rejoices to think that he now hopes to escape from some of the administrative cares which have eaten into the leisure which otherwise he would have devoted to scientific research, and assures him that his name and work will be inseparably connected in future with the history of the rise of the University of Leeds."

The title of Emeritus Professor was conferred upon the following: Percy Fry Kendall, professor of geology, 1904–1922, who retired after reaching the age limit in September; John Goodman, professor of civil and mechanical engineering, 1890–1922, who resigned his chair in September.

Dr. W. H. Pearsall, lecturer in the department of botany, was appointed reader in botany in recognition of his contributions to learning and research, especially in ecology.

A COURSE of eight lectures on "Changing Geographical Values" will be delivered by Sir Halford

Mackinder on Wednesdays at 5 P.M., beginning January 24, at the London School of Economics and Political Science, Houghton Street, W.C.2.

PART I., consisting of ten lectures, of a course on Oil Well and Refinery Technology and Geology of Petroleum, will be given at the Sir John Cass Technical Institute, Jewry Street, Aldgate, E.C.3., during the coming term. The opening lecture, on Monday, January 15, at 7 P.M., will be by Sir John Cadman on "Imperial Aspects of the Petroleum Question."

THE Bureau of Education of the Government of India has just issued a second volume of "Selections from Educational Records," edited by J. A. Richey (Calcutta, Superintendent of Government Printing, India, pp. 504, rupees 6½). The period covered by these selections, 1839–59, was one of great educational activity in India, during which provincial systems of education were gradually evolved, and many of the documents reproduced in this volume are of great interest, as are likewise the accompanying series of portraits of statesmen, administrators, missionaries, and unofficial patrons of education. The frontispiece is, appropriately, a portrait of James Thomason, Lieutenant-Governor of the North-western Provinces, 1843–53, who of all the administrators of those times rendered the greatest services to the cause of education in India. Among these not the least was the establishment of the Engineering College at Roorkee which bears his name. Had his appreciation of the needs of the time in regard to the teaching of applied science been more fully shared by the court of directors and their successors, there might have been in India developments comparable with those which in the United States of America followed the adoption by the Federal Government of the policy of endowing colleges of agriculture and mechanical arts. A number of interesting documents are grouped together under the heading: the beginning of professional education—medical, engineering, and legal—and a useful bibliography is given at the end of the volume.

STRIKING testimony of the excellent morale of the students of the University of Hong-Kong was given in the course of an address delivered on November 14 at the Royal Colonial Institute by Sir Frederick Lugard, to whose initiative the inception of the University was primarily due. After speaking of the need for training character in African dependencies, he said: "A university was founded in Hong Kong in 1912 mainly for Chinese students. In the forefront of its declared objects the principles of co-operation and discipline were laid down. This year the community was disorganised by a series of strikes of a political nature. Trade and social life were alike paralysed. It seemed inevitable that the students—as in Egypt and India—would espouse the cause of reaction. But the Vice-Chancellor reports that though it would have been entirely in accord with Chinese student practice elsewhere that the undergraduates should demonstrate on the same side, what actually occurred was a very striking testimony to the success obtained in inculcating the lessons of co-operation and discipline. When the whole of the servants joined the strikers the students devoted themselves with the utmost cheeriness to cooking and to menial household duties. Sir W. Urungate adds that the hostels had never been cleaner. When the staff of mechanics went out the students manned the power station and the medical students unanimously resolved to carry out hospital duties, which are regarded by Chinese as especially derogatory." On the re-establishment of stable government in China the potential usefulness of this university will be vastly increased and it is to be hoped that it will be enabled to rise to the height of its great opportunities.

Societies and Academies.

LONDON.

Aristotelian Society, December 4.—Prof. Wildon Carr, vice-president, in the chair.—Gerald **Cator**: The one and the many. Contents of monadic type, which seem to occur in experience, prove on examination to be "convergence illusion effects." To admit this, however, is fatal to the claims of logic. The question, "How are synthetic judgments possible?" can only be answered by the denial that there can be genuine judgments, as contrasted with psychological compositions of representations. The writ of logic, we should have to say, does not run in our world. To this dilemma the intellectualist metaphysic of St. Thomas Aquinas offers a legitimate though not dialectically-necessary way of escape. According to it every character of the world, correlative to an intelligence of any grade, is a function of the position of that intelligence in the scale of beings, and the human intelligence is intelligence at threshold value. It follows that the form of the human universal will be the unification of a multiplicity by reference to a *point de repère*. But this is precisely the structure of a "convergence illusion effect." Convergence illusion effects *may*, therefore, be genuine universals at threshold value, and consequently our world *may* be continuous with the intelligible world.

Society of Public Analysts, December 6.—Mr. P. A. Ellis Richards, president, in the chair.—E. W. **Blair** and T. Shirlock **Wheeler**: A note on the estimation of form- and acet-aldehydes. In investigations of the action of oxygen and ozone on various hydrocarbons, the formaldehyde and acetaldehyde present were estimated by finding the total aldehydes by Ripper's bisulphite method (*Monat. für Chem.*, 21, 1079), and formaldehyde alone by the cyanide method. In solutions containing formaldehyde, formic acid, hydrogen peroxide, and a trace of ozone these substances were estimated *seriatim*, formic acid with N/100 alkali, ozone with neutral potassium iodide, hydrogen peroxide by Kingzett's method (*Analyst*, 9, 6), and formaldehyde by Romijn's method.—H. A. **Peacock**: Note on the presence of sulphur dioxide in cattle foods after fumigation. Sulphur dioxide may be absorbed by cattle cakes and meals during fumigation, but after about a week the sulphur dioxide disappears. The amount absorbed depends on the variety of cake—the harder cakes absorbing less than the softer—and the condition of the feeding stuff, *i.e.* whether in block or powder form.—C. H. Douglas **Clark**: A sliding scale for the convenient titration of strong liquids by dilution and use with aliquot parts. The device enables the operator to see at once what alternative dilutions are available in any particular case in order to obtain a convenient burette reading at the end of titration, and it assists in choosing the most suitable dilution.—D. W. **Steuart**: Some notes on the unsaponifiable matter of fats. The proportion of sterol in the unsaponifiable matter varies from 48 per cent. in maize oil to 7 per cent. in palm oil; and from 38 per cent. in lard to 9 per cent. in hardened whale oil. Highly hardened fats still contain sterol. The cholesterol acetate of animal fats melts at 114 to 114½° C.; the phytosterol acetate of vegetable fats is a mixture, a fraction of which melts at 125° or above, but some pure vegetable oils yield a fraction melting about 114° C. These facts are utilised in analysing margarines.—Norman **Evers** and H. J. **Foster**: Note on the sulphuric acid test for fish liver oils. The addition of natural oils increases the sensitiveness of the test to

a remarkable extent. The brown colour produced by sulphuric acid with liver oils after oxidation, behaves in exactly the same manner as the violet colour with the fresh oils, being similarly increased by the addition of natural oils. Oxidation of the natural oils destroys this power, but it is unaffected by hydrogenation.

The Optical Society, December 14.—Sir F. W. Dyson, president, in the chair.—T. **Smith**: A large aperture aplanatic lens not corrected for colour. A lens suitable for spectroscopic work with aplanatic corrections for all zones may have as large an aperture as *f*/1 or still greater, all the surfaces being strictly spherical. An actual lens made by Messrs. Ross, Ltd., of 3 inches focal length and 3 inches aperture possesses corrections comparable with those given by the theoretical investigation. With a slightly reduced aperture, correction for colour may be obtained without prejudice to the quality of the spherical corrections. The production of suitable glass discs is the outstanding difficulty in the way of great increases in the relative apertures of telescope objectives.—T. **Smith**: The optical cosine law. The law of refraction, the sine law relating to coma, and other exact laws of optical instruments are particular cases of a very general law which assumes the form of a cosine relation. As an example of the application of the law, the principles which should govern the construction of a variable power telescope yielding aplanatic correction at all magnifications are investigated.—S. **Weston**: A constant bubble. The alteration in the length of the air bubble in a spirit level due to variation of temperature is avoided in the new type of level produced by Messrs. E. R. Watts and Son, Ltd., known as a "constant" bubble. The first consideration is to obtain the exact proportion of air and spirit. The cross section of the tube containing the liquid is so shaped that as the temperature is raised and the surface tension gradually decreased, only the cross sectional area of the bubble is affected, its length remaining unaltered.

PARIS.

Academy of Sciences, December 4.—M. Emile Bertin in the chair.—M. Guillaume Bigourdan was elected vice-president for the year 1923.—G. **Bigourdan**: The Observatory of Paris, on the 200th anniversary of its construction. An historical synopsis of the work done at the Observatory from its completion in 1672 to 1699.—Maurice **Hamy**: The measurement of small diameters by interference. A development of Michelson's formula, without the restriction $\alpha=0$ (α being the ratio of the width of the slits to the distance between their centres).—A. **de Gramont**: Quantitative researches on the line spectrum of vanadium in fused salts. Two tables are given showing the persistence of the chief vanadium lines by ocular and photographic observations. In the visible spectrum the sensibility is 1 in 1000, and this is increased by the use of photography to 1 in 100,000. The method can usefully be employed in the examination of minerals.—Sir William H. Bragg was elected correspondant for the section of physics, in the place of the late M. René Benoit, and J. B. Senderens correspondant for the section of chemistry, in the place of the late M. Barbier.—A. **Schaumasse**: Observations of the Skjellerup comet (1922*d*) made with the equatorial of Nice Observatory. Positions of the comet and comparison stars are given for November 29 and 30. The comet is of the 11th magnitude.—J. **Le Roux**: The gravitation of the systems. Reply to some criticisms by M. Brillouin.—J. **Haag**: The constancy of the homogeneity of the fluid representative of the different possible states of a gaseous mass.—Maurice and Louis **de Broglie**: Remarks on corpuscular spectra and the photo-electric effect.—Pierre **Salet**: The law of dispersion of prismatic spectra in the ultra-violet. In an earlier paper the author has given a formula which represents exactly the observed relation between the wave-length and the position of a line in the spectrum, and this was verified for wave-lengths between $\lambda 3800$ and 4900. Proof is now given of the validity of the formula in the ultra-violet to $\lambda 2250$.—F. **Croze**: The place of the ultimate lines of the elements in the spectrum series and their relations with the resonance lines.—Pierre **Steiner**: The ultra-violet absorption spectra of the alkaloids of the isoquinoline group. Papaverine and its hydrochloride. The absorption curve of papaverine is not that obtained by the addition of the absorption curves of its constituents: the effect of the isoquinoline nucleus preponderates.—Marcel **Sommelet**: Tertiary amines derived from benzhydrylamine.—Raymond **Delaby**: The alkylglycerols. The conversion of the vinyl-alkyl-carbinols into alkyl-glycerols. The ethylenic alcohol is treated with bromine in acetic acid solution, these converted into acetins by prolonged boiling with sodium acetate, and the products separated by fractional distillation. The acetins are hydrolysed by a solution of hydrochloric acid in methyl alcohol.—P. W. **Stuart-Menteath**: The San Narciso mine in Guipuzcoa.—P. **Viennot**: The tectonic of the region of Bagnères-de-Bigorre and of Lourdes.—Louis **Dangeard**: Contribution to the geological study of the bottom of the English Channel, based on recent dredgings by the *Pourquoi-Pas?* (August-September, 1922). The results are given on a chart, with special reference to outcrops of the Lias and Eocene.—M. **Lecointre**: The stratigraphy of the north of Chaouia (Western Morocco).—J. **Cluzet** and A. **Chevallier**: The radioactivity of the springs of Echaillon. The deposits forming these springs are rich in radiothorium. This is the only spa in France admitting the therapeutic utilisation of thorium emanation.—G. **Reboul**: The determination, in cloudy weather, of the vertical movements of the atmosphere: the influence of clouds on the velocity of displacement of depressions.—M. **Bridel** and G. **Charaux**: Centaureidine, a product obtained from centaureine, a glucoside from the roots of *Centaurea Jacea*. This substance, which has the composition of $C_8H_{16}O_8$, is probably a derivative of flavone.—M. **Aynaud**: Botrymycosis of sheep.

SYDNEY.

Royal Society of New South Wales, November 1.—Mr. C. A. Sussmilch, president, in the chair.—R. S. **Hughesdon**, H. G. **Smith**, and J. **Read**: The stereoisomeric forms of menthone. The ten stereoisomeric forms of *p*-menthan-3-one stated to be theoretically possible, and certain menthones and menthols derived by reduction from the optically active and inactive forms of piperitone are discussed.—E. **Hurst**, H. G. **Smith**, and J. **Read**: A contribution to the chemistry of the phellandrenes. Muta-rotation and optical inversion on the part of *l*-α-phellandrene α-nitrite occurs when it is dissolved in chloroform, benzene, or acetone, and maintained at 20° C.—H. G. **Smith**: Notes on the chemistry of certain Australian plant products. Pt. i. A resin coating the leaves and stems of *Acacia verniciflua*, the essential oil of the small leaved *Bæckia Gunniana*, and the rubber and wax from *Sarcostemma australe*, are discussed. The milky latex of *Sarcostemma australe* contains about 7 per

cent. of rubber, together with resin.—E. H. **Booth**: Notes on the photographic work of the Sydney University Eclipse Expedition, Goondiwindi, Queensland. The principle adopted was to give full exposures to ensure recording all required material on the plate, to develop to the point of general chemical fog, and to take from each plate a series of prints of different exposures, thus enabling a complete analysis of every degree of density in each plate to be made. This has the same value as a large number of individual exposures. The process appears to have been quite successful, giving a full range of prints showing detail from the extreme photographic limit of the outer corona into the prominences. An outline of exposures and subsequent photographic treatment is given. Photographs showing inner corona and prominences were displayed.—A. R. **Penfold**: The essential oils of two Myrtaceous shrubs, *Homoranthus virgatus* and *H. flavescens*. The shrubs are common to various parts of Northern New South Wales and Queensland. *H. virgatus* contains as principal constituent up to 80 per cent. dextro alpha pinene, sesquiterpene, amyl alcohol, and esters, and a paraffin of M.P. 65-66° C. *H. flavescens* contains 80 per cent. of the olefenic terpene "Ocimene," together with dextro alpha pinene, sesquiterpene, amyl alcohol, etc. This hydrocarbon is recorded for the first time in an Australian essential oil.—F. R. **Morrison**: The essential oil of *Kunzea corifolia*. This dark green bushy shrub, which is one of the commonest growing in the Port Jackson district, yields a light brown mobile oil of fragrant odour. The oil consists principally of dextro alpha pinene, a sesquiterpene closely resembling cadinene, an unidentified alcohol (the odoriferous constituent), and small quantities of acetic and butyric acid esters.—W. M. **Doherty**: A note on the food value of the snapper (*Pagrosomus auratus*). The percentage of fat in the snapper is very small, but it gave indication of the presence of the fat-soluble, growth-promoting factor, vitamin A.

Official Publications Received.

Report of the Department of Naval Service for the Year ended March 31, 1922. (Sessional Paper No. 17a—A. 1923.) Pp. 54. (Ottawa.)

Ministerio da Agricultura, Industria e Commercio: Directoria de Meteorologia. Boletim Meteorologico: Anno de 1916. Pp. vi+136. (Rio de Janeiro.)

The Indian Forest Records. Vol. 9, Part 4: The Constituents of some Indian Essential Oils. Parts 1-7. By J. L. Simonsen and Madyar Godal Rau. Pp. 36. (Calcutta: Government Printing Office.) 6 annas.

Forest Bulletin, No. 49: Note on Thingan (*Hopea oderata*, Roxb.). By A. Rodger. Pp. 15. 7 annas. Forest Bulletin, No. 50: Note on Gurjun or Kanyin. Compiled by W. Robertson. Pp. 7. 4 annas. (Calcutta: Government Printing Office.)

Union of South Africa. Fisheries and Marine Biological Survey. Report No. 2 for the Year 1921, by Dr. J. D. F. Gilchrist; with Introduction by H. Warington Smyth; and Special Reports 1: Heterosomata (Flat Fishes), by C. Von Bonde; 2: Physical and Chemical Observations, by Dr. C. Juritz; 3: Deep-sea Fishes (Part 1), by Dr. J. D. F. Gilchrist. Pp. iv+84+79+12 plates. (Cape Town.)

Transactions of the Leicester Literary and Philosophical Society, together with the Report of the Council for 1921–22, and Annual Reports of the Sections. Vol. 23, 1922. Pp. 74. (Leicester.)

The Annual Report of the Gresham's School Natural History Society, 1922. Pp. 12. (Holt, Norfolk.)

Department of Agriculture and Natural Resources: Weather Bureau. Annual Report of the Weather Bureau. Part 1: Work of the Weather Bureau during the Calendar Year 1919; Part 2: Hourly Meteorological Observations made at the Central Observatory of Manila during the Calendar Year 1919. Pp. 143. (Manila: Bureau of Printing.)

Diary of Societies.

SATURDAY, DECEMBER 30.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. H. H. Turner: Six Steps up the Ladder to the Stars (2). The Discovery of the Planet Neptune (Juvenile Lectures).

MONDAY, JANUARY 1.

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at University College), at 2.30.—Dr. C. W. Kimmins: The Child and the Cinema.
ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 3.30.—Lt.-Comm. A. S. Elwell-Sutton: Up the Tigris (Christmas Lecture to Young People).
CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 5.—Miss M. Drummond: Children's Drawings.
MATHEMATICAL ASSOCIATION (at London Day Training College), at 5.30.—Dr. S. Brodetsky: Gliding.
NATIONAL LEAGUE FOR HEALTH, MATERNITY, AND CHILD WELFARE (at University College), at 5.30.—Health Problems of Adolescence.

TUESDAY, JANUARY 2.

MATHEMATICAL ASSOCIATION (at London Day Training College), at 10.—Prof. E. H. Neville: A Statement respecting the forthcoming Report of the Sub-Committee on the teaching of Geometry.—At 11.—W. C. Fletcher: The Uses of Non-Euclidean Geometry to Teachers.—At 12.—Prof. R. W. Genese: Simple Geometrical and Kinematical Illustrations of the Plane Complex.—J. Brill: A certain Dissection Problem.—At 2.30.—Sir Thomas L. Heath: Greek Geometry, with special reference to Infinitesimals (President's Address).—Prof. A. Lodge: Differentials as the basis for teaching the Calculus.
ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. H. H. Turner: Six Steps up the Ladder to the Stars (3). Photographing the Stars (Juvenile Lectures).
NATIONAL LEAGUE FOR HEALTH, MATERNITY, AND CHILD WELFARE (at University College), at 5.30.—Dr. J. Kerr: Physique and Growth.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.—H. Lamplough: The Lamplough Flash Lamp.—A. C. Banfield: A Demonstration of the German Aeroplane Camera now in the Society's Museum.
RÖNTGEN SOCIETY (at Institution of Electrical Engineers), at 8.15.—Dr. A. E. Barclay: The Organisation and Equipment of a Modern X-Ray Department with special reference to the New Department at the Manchester Royal Infirmary.—Major C. E. S. Phillips: An Electroscope of New Design.

WEDNESDAY, JANUARY 3.

ROYAL SOCIETY OF ARTS, at 3.—C. R. Darling: The Spectrum, its Colours, Lines, and Invisible Parts, and some of its Industrial Applications (Dr. Mann Juvenile Lecture).
PHYSICAL SOCIETY OF LONDON AND OPTICAL SOCIETY (at Imperial College of Science and Technology), at 3-6, and 7-10.—Annual Exhibition of Scientific Apparatus.—At 4.—W. Gamble: Reproduction of Colour by Photographic Processes.—At 8.—Prof. E. G. Coker: Recent Photo-Elastic Researches on Engineering Problems.
ROYAL MICROSCOPICAL SOCIETY (Biological Section), at 7.30.

THURSDAY, JANUARY 4.

GEOGRAPHICAL ASSOCIATION (at Birkbeck College), at 12.—Sir John Russell: The Influence of Geographical Factors in the Agricultural Activities of a Population (Presidential Address).—At 2.30.—J. Fairgrieve: Report on his Recent Visit to the United States.—At 5.—H. Batsford: Types and Materials of Houses in England.
ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. H. H. Turner: Six Steps up the Ladder to the Stars (4). The Spectroscope and its Revelations (Juvenile Lectures).
PHYSICAL SOCIETY OF LONDON AND OPTICAL SOCIETY (at Imperial College of Science and Technology), at 3-6, and 7-10.—Annual Exhibition of Scientific Apparatus.—At 4.—Prof. E. G. Coker: Recent Photo-Elastic Researches on Engineering Problems.—At 8.—W. Gamble: Reproduction of Colour by Photographic Processes.
INCORPORATED BRITISH ASSOCIATION FOR PHYSICAL TRAINING (at University College), at 5.—Prof. M. E. Delafield: Hygiene as applied to Physical Training.
ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—H. Junkers: Metal Aeroplanes.
NATIONAL LEAGUE FOR HEALTH, MATERNITY, AND CHILD WELFARE (at University College), at 5.30.—Dr. W. Brown: Child Psychology and Psychotherapy.
INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—F. Creedy: Variable-speed A.C. Motors without Commutators.
CAMERA CLUB, at 8.15.—W. L. F. Wastell: The Evolution of the Lantern Slide.

FRIDAY, JANUARY 5.

GEOGRAPHICAL ASSOCIATION (at Birkbeck College), at 10.—Dr. Olive Wheeler: The Place of Geography in the Education of the Adolescent.—At 11.45.—Maj.-Gen. Lord Edward Gleichen: Permanent Committee on Geographical Names.—At 12.15.—Prof. W. S. Tower: Geography and Business Life.—At 2.30.—E. E. Lupton and others: Discussion on ways of increasing the Usefulness of Branches of the Association.—At 5.—Prof. P. M. Roxby: The Coming Industrialisation of China.
ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 3.30.—R. E. Priestley: Antarctic Adventures (Christmas Lecture to Young People).
NATIONAL LEAGUE FOR HEALTH, MATERNITY, AND CHILD WELFARE (at University College), at 5.30.—Prof. H. R. Kenwood: Health Education.
JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—W. Dinwoodie: Wave Power Transmission.

SATURDAY, JANUARY 6.

ASSOCIATION OF WOMEN SCIENCE TEACHERS (at University College), at 2.30.—Dr. Dorothy Wrinch: Relativity.
ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. H. H. Turner: Six Steps up the Ladder to the Stars (5). Two Great Streams of Stars (Juvenile Lectures).
GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.1), at 3.—G. J. B. Fox: A Visit to Pompeii.